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THE SILK INDUSTRY OF JAPAN

WITH

Notes on observations in the United States of America, England, France and Italy

BY

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Glossary.-

Japanese terms have been explained wherever they occur in the text. The following short glossary is however useful.

Money.

10 rin=one sen.
100 sen=one yen (par value Re. 1 annas 9).

Weights.

10 mo=one rin.
10 rin=one fun=5·8 grains troy.
10 fun=one momme=58 grains troy.
=·1323 oz.
=3·75 grammes.
160 momme=one kin=1⅓ lbs.
1,000 momme=one kwamme or kamme or kan=8·27 lb
100 kin=133⅓ lbs. (weight of a bale of raw silk).

Land measure.

1 tan=1186 sq. yds. (a little less than ¼ acre).
10 tan=one cho=2·45 acres.

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THE SILK INDUSTRY OF JAPAN, WITH NOTES ON OBSERVATIONS IN THE UNITED STATES OF AMERICA, ENGLAND, FRANCE AND ITALY

BY

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INTRODUCTORY.

This publication is the result of a study made in Japan in 1929.

The annual value of raw silk produced in Japan is computed about 1928-29 at about 700,000,000 Yen* and that of silk manufactures at about 200,000,000 Yen. About forty per cent. of the total exports of Japan is silk and silk products which thus constitutes the source of a very large portion of her wealth. The mere statement of this fact, however, does not convey an adequate idea of the benefits which the Nation as a whole derives from this industry.

I concerned myself mainly with the raw silk industry in Japan and went into the manufacturing part in a general way in order to be able to understand its requirements as regards raw silk. The following summary gives a general idea of the whole industry, and in the succeeding nine parts every important aspect of the raw silk industry is dealt with. Part X gives a general idea and development of the weaving or manufacturing industry.

An attempt has been made to elucidate the means and methods by which this vast industry has been developed with the hope that it will be of interest to all interested in sericulture in India. The United States of America utilises for her weaving industries about half of the world's exportable raw silk, and of this quantity Japan supplies about 90 per cent. On account of the high cost of labour, America depends on efficient and quick machinery for the throwing and weaving operations. Therefore the demand has been for very high class uniform raw silk which can be worked smoothly in the machines, and America has devised appliances for testing the raw silk for this purpose. Japan has made constant attempts to meet this demand and adopted up-to-date appliances and methods for production as well as for testing the quality. An attempt has been made to acquaint readers with these appliances and methods.

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* Par value of *Yen* is one rupee nine annas.

I spent about five months in Japan from June to November, which is the period of sericultural activities, and worked in the following places, *viz.*, the Imperial Japanese Sericultural Experiment Station, Nakano, the Experiment Station of Saitama Prefecture at Kumagaya and the Yokohama Conditioning House, and I also visited several other experiment stations, sericultural schools and colleges, mulberry plantations, rearers' houses in villages, cold storages, cocoon markets, cocoon stores, reeling factories, throwing factories, controlling stations, silk exchange, silk exporting firms, technical institutes, associations, guilds, co-operative societies, dyeing, printing and finishing factories, weaving establishments, and cloth conditioning houses. For this purpose I had to undertake journeys to different parts of Japan.

From Japan I crossed over to the United States of America and visited, in New York and its neighbourhood, the laboratories of the United States Testing Co. for testing raw silk and silk yarn and also some throwing and weaving factories.

Then I crossed over to England. Illness prevented me from being able to undertake journeys to silk-manufacturing places here and on the continent, but the Imperial Institute, the London Silk Conditioning House and some silk importing firms were visited.

In France I visited Lyons, the well-known silk manufacturing centre, the silk-conditioning house in this city, the laboratory of Dr. Paillot, an authority on silk worm diseases at St. Genis Laval, and the National Sericultural Office at Valence.

In Italy I visited the biggest silk-conditioning house and the Sericultural Institute at Milan and reeling and throwing factories in the neighbourhood and worked for a short time at the Sericultural Station at Padua. In Part III and Appendices B and C relevant notes on observations in the United States of America, England, France and Italy have been added.

My thanks are due to Mr. McKerral, Director of Agriculture, Burma, for recommending study leave for four months in Japan and to the Burma Government for sanctioning it. The rest of the total period of one year was ordinary leave. In Japan I am indebted to many gentlemen, Officials, Professors and Experts in Universities and Experimental and Research Stations, and Managers of Reeling Factories and various Societies and Firms. They are too numerous to be mentioned here individually. I shall always remember gratefully their politeness and help. By some I have been fortunate enough to be considered a friend. The introduction kindly given by Mr. S. Kuga, Acting Japanese Consul at Rangoon, led me into the confidence of Mr. T. Ishiguro, Director of the Sericultural Bureau, to whom I am indebted for advice and introduction to all important institutions, factories and firms. Then I should mention my indebtedness to Dr. E. Hiratsuka, Director of the Imperial Sericultural Experiment Station, and to the entire staff of this station, especially to Dr. M. Honda, Dr. K. Katsuki, and Dr. I. Osawa. I should also make special mention of Mr. Nonaka, Chief Expert of Kumagaya Experimental Station and the Experts of the Yokohama Silk Conditioning House. The Indo-

Japanese Association, Tokyo, helped me with introductions to several places and in various other ways. I received unstinted help from Mr. Ovens, British Consul at Tokyo, throughout the entire period of my stay in Japan.

In the United States of America no special introduction is necessary for visiting laboratories and factories. I should make special mention of the help received from Mr. H. E. Bishop, Manager, United States Testing Co., and from the Silk Association of America, although I was not introduced to them by any one.

In London Sir James Mackenna, who had been the head of the Institutes and Departments where I worked in India and Burma, was extremely kind to me in various ways and the pleasant memories I have carried away of London are mostly due to him. I have to express my thankfulness to the authorities of the places mentioned above which I visited in England, France and Italy. In France and Italy introductions were kindly arranged for by the High Commissioner for India through the Foreign Office and the British Embassies and but for the facilities arranged for by Mr. S. E. Kay, British Consul at Lyons, and Mr. A. C. Charlton, His Britannic Majesty's Consul-General at Milan, hardly any work would have been possible in these countries. I express my thankfulness to them and to Professor Pigorini, Director of the Sericultural Station, Padua.

Last of all, I should say that but for the help of Mr. K. Shamshuddin Khan, Assistant Superintendent of Sericulture, Mysore, on deputation in Japan, who was acquainted with the language and the subject matter of the study, it would not have been possible for me to complete as much as I have been able to do in so short a period.

SUMMARY.

The industry is broadly divisible into (I) Production and export of raw silk, *i.e.*, raw silk industry and (II) Manufacture of cloth from the raw silk and its export.

THE RAW SILK INDUSTRY.

The raw silk industry comprises (1) mulberry cultivation, (2) production of eggs, (3) rearing of worms, (4) reeling of cocoons into raw silk, and (5) trade in raw silk.

Mulberry cultivation. Mulberry is cultivated by the farmers who rear the worms. But as the entire mulberry is grown from grafts (not cuttings) it gives occupation to a class of farmers who grow seedlings and grafts and sell them. This is an industry by itself, followed by about 199,000 men, and the approximate annual value of their sale is about yen 4,645,000. Production and sale of seedlings and grafts are carried on under the supervision of Government Controlling Stations (*Torishimari Jo*). The area under mulberry is about 1,523,000 acres or about one-tenth of the total area under cultivation in Japan. The commonest forms of mulberry are bush (69 per cent.) and medium trees (16 per cent.).

Egg production. The rearers of silk worms are not permitted to produce eggs but have to purchase them from the stock produced under strict Government supervision. Eggs reared for the production of the raw silk are almost wholly the first generation crosses of Chinese, Japanese and Italian races of worms. The parent races have been selected by the Experiment Stations after trying all kinds of silkworms collected from all over the world, are maintained and bred to the extent required and are supplied to about 8,000 egg-producing establishments who produce under the supervision of the Controlling Stations the first generation cross eggs for the rearers. Twenty-eight moths are got to lay eggs on one sheet of paper which is known as an egg-card and sells for $1\frac{1}{2}$ to $2\frac{1}{2}$ yen. The number of such egg-cards used in 1928 was about 18,890,000

Rearing of worms. This work is carried on by about 2,165,000 farmers representing about 40 per cent. of the total number of farmers in Japan. Rearing is done generally in the houses. Absence of the parasitic fly and suitability of climatic conditions enable rearing to be carried out even out of doors.

There are two rearing seasons. One is in spring (May-June) and the other in summer-autumn (August-October) usually spoken of simply as summer or autumn. The spring crop produces the best cocoons. Scientific methods have enabled the summer crop to be much improved and it now equals the spring crop in volume. In some places two crops of cocoons are reared in summer. The scientific methods essential for successful rearing are cold storage of eggs under about 40°F for several months and for summer rearing such storage combined with treatment with

hydrochloric acid. An electrical treatment in place of the acid treatment has recently been evolved in the Kyoto Sericultural College but has not yet been adopted in practice. Eggs are sold to the rearers after cold storage and acid treatment.

The farmers as a rule sell the cocoons as soon as formed and on the average had in 1928-29 an income of Yen 253 (about Rs. 400) each from rearing worms. The average area of mulberry per rearer is about three-fourth of an acre.

Reeling. Reeling is altogether a separate industry and involves (1) Purchasing cocoons, (2) Stifling cocoons (for details see section* 6), (3) Drying cocoons (process detailed in section 13), (4) Storing cocoons (see sections 14 and 15), (5) Sorting cocoons (see section 16), (6) Actual reeling and re-reeling (see part II), (7) Testing of the raw silk (see part III), (8) Dressing and packing of the raw silk and despatch for sale (see sections 17, 18 and 19).

Reeling concerns, *i.e.*, filatures have to arrange for all this but some of the processes are, or are becoming separate industries.

Trade in raw silk. The raw silk produced by the filatures, except by a few very large ones who export on their own account, is sold through commission agents (*Tonyas*) who deal with exporting firms. After the transaction is settled the silk has to be conditioned by the Government Conditioning Houses as the Law does not permit export except on conditioned weights. The charge for conditioning is nominal, being one Yen for one bale of 133⅓ lbs.

The silk being a very valuable property, its ware-housing at the ports of export, *viz.*, Yokohama and Kobe, is properly looked after. *Tonyas* and exporters have usually their own ware-houses.

The Government has built four large ware-houses in connection with the Conditioning House at Yokohama and have leased them to the Imperial Silk Warehouse Company, Limited. There are ware-houses at Kobe also.

RESEARCH AND EXPERIMENT.

The industry owes its success principally to research and experiment. The principal station at Nakano, wholly occupied in research for every phase of the raw silk industry, has a staff of about one hundred. The results from this station are passed on to 76 Experimental Stations, scattered in the districts, with a staff of about 400 which carry out local research and experiment, produce about forty per cent. of the parent worms required by the egg producers for producing the common cross seed for rearers, supply mulberry seeds and seedlings, look after demonstration mulberry gardens in the villages, train students and carry out a certain amount of propaganda. The annual budget of the Research and Experiment Stations is about Yen 2,500,000.

CONTROLLING STATIONS.

In addition to the above there are 343 Controlling Stations with an expert staff of 833 which (*a*) supervise the production of about sixty per cent. of the parent

* **Sections 1 to 60, numbered continuously in arabic numerals in the text.**

stock of worms required by the egg producers, (*b*) look after production of the entire stock of common cross seed for the rearers by the egg producers, (*c*) carry out examination of the mother-moths for disease with the help of 70,000 microscopists, (*d*) control trade in eggs and raw cocoons, (*e*) look after preparation, examination and sale of mulberry seedlings and grafts, there being regulations for the examination and passing of mulberry seedlings and grafts, (*f*) help the formation and work of all kinds of sericultural guilds, associations and co-operative societies, (*g*) collect, prepare and publish statistics, and (*h*) concern themselves in all matters for the improvement of the sericultural industry. The annual budget of the Controlling Stations is about Yen 2,500,000.

WORK AMONG AND HELP TO THE FARMERS.

Constant efforts are made to improve mulberry and rearing methods.

In the case of mulberry—

(*a*) *For nursery men.* (1) Gardens of stocks and scions are established for demonstration; stocks and scions are distributed, grafting methods are demonstrated and specialists are trained, (2) Lectures are arranged for grafting, nursery methods and prevention of diseases and pests, (3) Nursery owners are encouraged to form into societies in order to remove bad practices and defects and to prevent or remedy diseases and pests. Sometimes a subsidy is given for this purpose.

(*b*) *For farmers.* (1) There are specialists to guide and give advice about mulberry cultivation, (2) Subsidy is given for the undermentioned enterprises to municipal or rural agricultural committees, sericultural associations or other bodies, *viz.* :—(i) Distribution of young mulberry plants, (ii) Establishment of mulberry gardens and nurseries for improving mulberry, (iii) Replanting of old or decayed mulberry. Great stress is laid on this and the present budget for this subsidy is about Yen 611,000, (iv) Establishment of separate gardens for spring and autumn rearing, (v) Improvement of medium trees in preference to bushes, (vi) Establishment of late varieties in order to improve autumn rearing, (vii) Employment of specialists for improving mulberry, (viii) Establishment of demonstration gardens, (ix) Exhibitions and shows and (3) Loans are granted at low rates of interest to improve gardens affected by pests, diseases and frost. In 1927 to alleviate damage by frost a loan of Yen 8,330,000 was issued.

In the case of rearing :—(1) There are specialists to give advice about rearing, (2) Subsidy is given to sericultural associations for (*a*) employing sericultural demonstrators, (*b*) co-operative rearing of young worms and employing demonstrators for this purpose, (*c*) establishment of co-operative mulberry gardens for co-operative rearing of young worms, (*d*) equipment, lectures and demonstrations, (*e*) purchase

of suitable eggs co-operatively, (*f*) co-operative sale of cocoons, (*g*) arranging for drying and ware-housing cocoons and selling cocoons in the dried state, Government giving 40 per cent. of the cost of drying plant and warehouse. The budget in 1929 for this purpose was Yen 765,656, (*h*) loans are granted at a low interest when the price of cocoons goes very low. In 1928 a loan of Yen 50,000,000 was granted.

Sericultural Education.

Primary education for a period of six years is compulsory for all boys and girls in Japan. The curriculum includes elementary chemistry, physics, botany and zoology which deals with the life-history of the silk worm as a natural history subject. There are 241 sericultural, agricultural and other middle schools which teach sericulture and are properly equipped with rearing houses, etc., for the purpose. There are three sericultural colleges which impart sericultural education of the highest type. Four Imperial Universities also have agricultural faculties with a regular sericultural course.

Sericultural Training.

The experimental stations, except the main one at Nakano, keep under training with a stipend, usually for a year, 50 to 100 students who are usually boys and only in some cases girls. The controlling stations train microscopist girls, the course lasting usually for three months. Filatures train their own reelers, the period lasting six months to a year. Each filature has a small department where probationers work.

Sericultural Budget.

The consolidated budget of the 47 prefectures or districts in Japan is quoted. This gives some idea of what is done for the industry.

Consolidated budget of Prefectural Governments under different headings for 1928.

I. Improvement of mulberry—	Yen.	
1. Expenditure on specialists	162,927	
2. Subsidy	374,402	
3. Miscellaneous	126,996	
		664,325
II. Improvement of rearing—		
1. Expenditure on specialists	577,835	
2. Subsidy for specialists in villages	348,969	
3. Subsidy for encouragement of co-operative societies	312,401	
4. Miscellaneous	283,317	
		1,522,522
III. Improvement of seed (eggs)—		
1. Subsidies	44,628	
2. Miscellaneous	7,850	
	——	52,478

IV. Improvement of reeling—		
1. Expenditure on specialists	153,098	
2. Subsidy for specialists or equipment . . .	37,532	
3. Miscellaneous	157,801	
		348,431
V. Expenditure on Experimental and Controlling Stations—		
1. Torishimari Jo (controlling stations)	2,479,832	
2. Sangyo Shikenjo (experimental stations) . . .	2,112,665	
3. Conditioning Houses	890,924	
4. Teachers	303,458	
5. Miscellaneous	334,741	
		6,121,620

National or Imperial Government's budget for 1927.

A. For the industry—	Yen.	
1. Mulberry improvement	22,660	
2. Cocoon improvement	37,000	
3. Disease investigation	173,000	
4. Aid to the Raw Silk Association of Japan (Sanshi-gyo Do-gyo Kumiai Chuo-Kai)	13,000	
5. Aid to straw ware and dried cocoon trade . .	604,800	
6. Experimental stations (Sangyo Shikenjo) . . .	460,000	
7. Silk conditioning	438,233	
		1,748,693
B. For education—		
1. Kyoto Sericultural College	150,000	
2. Tokyo Sericultural College	180,000	
3. Ueda Sericultural College	180,000	
4. Kogoshima Sericultural College	2,000	
		512,000

Japan has been able to build up this huge industry principally because she has been spending about Yen 11,000,000 every year for research, experiment, propaganda and subsidy. This amount does not include the expenditure on sericultural education in schools and the four universities.

Guilds, Associations and Societies among Sericulturists.

There are two associations embracing the whole of Japan, *viz.*, (1) the Raw Silk Association of Japan, which deals with the improvements and trade of raw silk only, and (2) the Silk Association of Japan, which deals with sericulture proper, *viz.*, mulberry cultivation, rearing and cocoons.

The Silk Association has a branch in each prefecture (*i.e.*, district). The prefectures have the following also, *viz.*, guild or society of nurserymen, guild of egg producers as well as of sellers, association of sericultural demonstrators, guild of cocoon and silk brokers, guild of filatures, co-operative filature and league of rearers' associations. In some districts there are cold storage societies.

In the sub-divisions there are branches of the first six societies of the district league and in most of them cocoon drying and ware-housing societies are coming into existence.

In the villages there are only rearers' societies and if more than one in a village they form into unions.

All of these societies are formed and work under rules approved by the Ministry of Agriculture.

THE MANUFACTURING INDUSTRY.

The value of the export goods is estimated at about Yen 200,000,000. This industry makes use of (1) all kinds of raw silk produced in the various methods of reeling, (2) spun silk from silk waste, and (3) rayon (formerly known as artificial silk) either alone or mixed with silk.

The spun silk industry like the reeling industry owes its origin to the efforts of the Government which started the first spinning mill in 1877. At present the spinning mills in Japan work about 350,000 spindles. The most famous fabric woven from spun silk known as Fuji silk, is used in ladies dresses, shirts, handkerchiefs, curtains, linings, etc. Rayon mills have grown up in Japan. They use indigenous raw materials and also import pulp. Rayon fabrics plain, dyed and patterned are largely woven for export to Asiatic countries especially, including India. Of the fabrics woven with raw silk, the most famous is that known as *habutae*, and crepes, satins, georgettes, taffetas and other descriptions of woven fabrics to the number of about fifty are woven for export.

The noticeable features about the manufacturing industry are (1) that they are woven on domestic looms worked by electric power, each household having from one to several looms and carrying on the work like a home industry, (2) that ready-made yarns, dyed and twisted, are used in most cases, (3) washing, calendering and finishing of the woven stuff are carried out not by weavers but in finishing establishments.

Exports are effected through weavers' associations formed for the welfare of the weaving industry. These associations frequently send representatives to study the requirements of the consuming markets and advise the weavers as to how to meet these requirements. Formerly they also examined and passed the woven pieces for export. This examining or conditioning of export goods has now been taken over by Government, which has established cloth conditioning houses in

twelve different centres and has fixed by law specific standards regarding length, breadth, weight and number of threads used in warp and weft in the case of different kinds of cloth. Pieces not satisfying these standards are rejected and passed ones have to bear a stamp which is examined by the Custom House. The pieces for export are also examined for defects in weaving, cuts and stains and are rejected if such defects are present. In 1928 a total of 3,315,604 pieces were conditioned in the different centres and 87,547 were rejected.

The manufacturing industry too is backed by research and experiment. The Imperial Institute of Silk Industry is engaged in research and experiment on the properties of raw silk in all its stages up to the production of finished woven goods, including dyeing, printing and finishing. The Engineering University in Tokyo and Technical Institutions in all important weaving districts provide facilities for training in weaving, dyeing, printing and finishing.

PART I.—THE SERICULTURAL INDUSTRY.

1. MULBERRY.

Mulberry is the foundation of the sericultural industry and on the whole accounts for more than fifty per cent. of the expenditure in sericulture.

In earlier times mulberry used to be grown in small plots among fields or near houses. But with scientific improvement regular plantations were started. At present small plots form about thirteen per cent. of the total area under mulberry, which is about ten per cent. of the cultivable area in Japan. Extensive stretches of level fields are under mulberry which is also grown side by side with other crops and on hill sides. No irrigation is resorted to as the rainfall is very well distributed throughout the year.

Varieties. About 385 distinct varieties of mulberry are recognised in Japan. But *Morus multicaulis, M. alba* and *M. bombycis* (determinations according to Koidzumi. *Bulletin Imperial Sericultural Experiment Station,* Vol. II No. I) are considered the important original varieties from which, by artificial and natural crossing, many varieties have been evolved. The following nine varieties are commonly grown in Japan at present :—

(1) *Roso* (*Morus multicaulis*) is the best common variety and forms about 16 per cent. of all the common varieties or about 20 per cent. if the allied forms are included.
(2) *Ichihe* (a natural cross between *M. multicaulis* and *M. bombycis*).
(3) *Kairio nezumigayashi* (*M. alba*).
(4) *Riso* (*M. multicaulis*).
(5) *Simanouchi* (*M. alba*).
(6) *Kasuga* (*M. multicaulis*).
(7) *Akagi* (a natural cross between *M. multicaulis* and *M. bombycis*).
(8) *Tsuruta* (a natural cross between *M. multicaulis* and *M. bombycis*).
(9) *Goroji* (*M. bombycis*).

There are many other varieties grown less commonly. Of the above (1) and (2) are most common. Nos. (2) and (3) do not produce any seed and are propagated by grafting on *Roso* stock. Nos. (1) to (6) are considered stuitable for the southern parts of Japan with a milder climate and Nos. (7) to (9) for the northern parts, No. (9) being suitable for a severe winter. All these varieties are large-leaved and, in fact, so are practically all the varieties of mulberry grown. After the winter when all growth is stopped, different varieties bud at different times. Of the cultivated forms early budding varieties represent about 19 per cent., late budding ones about 23 per cent. and those budding midway between early and late ones about 58 per cent. These are regulated for convenience of rearing.

Methods of Cultivation. Grafts. At present only grafts are cultivated. As a result of long-continued experiments it has been found that grafts develop a better

root system than seedlings, layerings or cuttings. Layering however is still in use. For grafting, *Roso* seedlings are used as stock most commonly and also a variety of *M. Nigra* (*Cattaneo*) in some places. Seeds are collected in May-June and sown in seed-beds in July. By March next the seedlings are about 2 feet high or higher. Scions are taken from old plants, grafted, and these grafts are put in the ground in March-April (Fig. 1). Harvesting is not commenced before May or June of the following year. Later on, pruning is given just before spring. In summer and autumn leaves are plukced carefully, leaving about half of the leaf stalks.

Forms. Four forms of mulberry are grown. (1) *Negari* or bush (Fig. 2). By means of pruning, the plants are kept low, the head of the stem being practically level with the ground or only a few inches above it. The plants are about 3 ft. apart in the row and the rows about six feet apart. This is about the general practice though shorter distances, 2 feet and 5 feet, are observed in many places. One graft is planted at one place and the stem thickens. Every year at the beginning of the spring all branches are pruned off close to the head. The branches grow on a mature stem, though low, and this gives a better quality of leaves than the bush grown on the Bengal system. Budding and grafting are frequently practised on the stem heads.

(2) *Chugari* or *Nakagari* or medium trees; (Fig. 3). Grafts are planted in the same way as the above but the stem allowed to grow to a height of about 2 feet (a low form) or to about five feet (a high form). In this case the distance between plant to plant is commonly about six feet or smaller down to four feet and that between the rows is six feet. Pruning given is about the same as in (1).

(3) *Takagari*, or pruned trees, are grown about 12 feet apart and the stem allowed to grow to a height of about 8 or 9 feet. The branches are pruned when thick. Two plantations which I saw did not seem to grow well.

(4) *Tatedoshi* or unpruned trees which are allowed to grow naturally without pruning.

Of the total mulberry area, bushes form about 69 per cent., medium trees about 16 per cent., pruned trees about 5 per cent. and unpruned trees about 10 per cent. As regards yield of leaves in two crops per *tan* (*i.e.*, 1,186 sq. yds. or a little less than but nearly ¼ acre), bushes in the south on the average yield about 365 *Kan** which works out at about 12,100 lbs. per acre, medium trees about 316 *Kan*, pruned trees about 279 *Kan* and unpruned trees about 244 *Kan*. Dr. Osawa gave an estimate of possible yield of about 400 Kilograms of green cocoons in spring and about 300 Kilograms in autumn from one acre of good bush mulberry. According to the figures published by the Agricultural Department, the average yield for the whole of Japan is about 900 *Kan* leaves per acre, sufficient to produce about 60 *Kan* or 500 lbs. cocoons. In the northern regions the yield is less than half of these figures. Medium trees suffer less from diseases and floods than bushes and are convenient for tillage operations. Therefore this form is now being encouraged.

* *Kan*-8½ lbs.

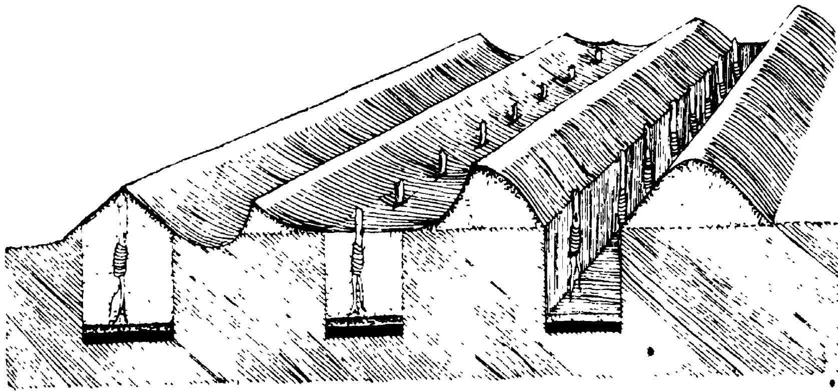


Fig. 1. How planting of grafts is done. (After Yendo and Higuchi.)

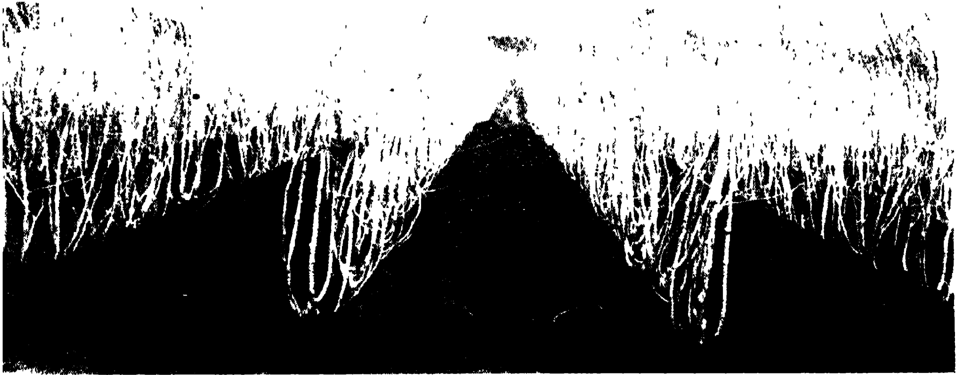




Fig. 2. Negari or bush mulberry. In the lower figure part of the crop has been pruned for use in May-June The upper figure shows a bush plantation in winter.

Manuring. The experiments of Dr. Hiratsuka, Director of the Imperial Sericultural Experiment Station, show that in the fifth stage, when the largest quantity of food is taken, the silk worm uses 25 per cent. of the digested solid and 65 per cent. of the digested nitrogen in the production of the silk substance. This fact demonstrates clearly the importance of nitrogenous manures for mulberry. Dr. Hiratsuka recommends 132 to 188 lbs. nitrogen to be applied in two instalments to the mulberry fields per acre, and sulphate of ammonia as the best form of manure for mulberry. In Japan on the average 20 yen is spent for manuring one *tan* of mulberry, *i.e.*, about 80 yen per acre. In some prefectures much larger quantities of manure are used; for instance the annual cost of manure in Okayama is about 200 yen per acre, in Saga about 172 yen, in Fukui about 164 yen and in Kochi about 160 yen. Manuring is essential in mulberry and the yield varies directly with the amount of manure used up to the point recommended above.

Seasonal use of mulberry. Formerly, rearing of worms during the summer-autumn seasons was on a small scale. At present scientific improvements have enabled large-scale rearing in these seasons. Necessarily excessive harvesting in these seasons is causing much damage to the plants. Therefore attempts are being made to set apart different fields for spring and autumn and Government is encouraging this. At present plantations used only for spring rearing are about 18 per cent. of the whole, those for summer and autumn rearing about 13 per cent. and those for both seasons about 69 per cent. Experienced rearers are of opinion that only one harvest is good in Japan. Dr. Osawa estimated about 11,250 lbs. leaves with stem per acre in spring and the proportion of leaves to stem about 6 : 4, *i.e.*, about 7,500 lbs. leaves. A seed rearer in Gumma prefecture with fifty years' experience estimated about 8,900 lbs. of leaves per acre. The proportion of leaves to stem is very high on account of the large size of leaves.

Expenses of cultivation. Expenses vary from place to place. The figures given by the experienced rearer referred to above is as follows :—

For starting-

200 yen per acre for preparation of land.

30 yen for grafts and planting, each graft costing from 3 to 5 sen.

For upkeep -

60 yen per acre for labour.

80 yen for manure and other charges. Manure is applied twice in the year on 20th March and again on 10th July. He prefers fish manure but also uses sulphate of ammonia, oil-cake, pupa cake and mixture of sulphate and phosphatic manure (calcium phosphate). These manures and night-soil constitute all that are used in Japan for mulberry.

Planting is done in March-April and harvesting commenced next spring, *i.e.*, about May-June of the following year. Plantations come into full bearing in the seventh year and continue in full vigour up to the eighteenth year. Replanting is

better done in the twentieth year. This refers to bush and medium trees and this rearer prefers medium trees and is of the opinion that, if properly treated, yields in both systems are about the same. According to him, harvesting should be done only once and about 8,900 lbs. leaves can be obtained per acre. He has 20 acres of mulberry and keeps 67 men in spring and 22 in autumn. Plucking of leaves is done on a contract system, 3 sen being paid for one *Kan* leaves plucked and carried to the rearing house.

The average cost for producing one *Kan* leaves is calculated at one-fourth yen.

Production and sale of seedlings, grafts and layerings. This forms an occupation of nurserymen whose number in 1928 was about 199,000 and who carried on business worth about Y 4,645,000. The operations are controlled by special laws, nurserymen are licensed, all plants for sale have to be passed after examination and no plants under specified sizes or affected by diseases and insects are allowed to be sold. For details *see* Section 55.

2. EGG SUPPLY.

In Japan rearers of silkworms are prohibited by law from producing eggs for rearing. The Imperial Sericultural Experiment Station is engaged in testing silkworms from all over the world and selecting suitable ones for Japan. It recommended for rearing the F_1 crosses of certain races. These races are made available to the Prefectural Experiment Stations, which again test them for local conditions and adopt those found suitable for their locality. The parent worms are reared in these Prefectural Experiment Stations and made available to the licensed seed producers for producing F_1 cross or common seed for the general rearer. The Experiment Stations produce only about 40 per cent. of the total requirements of parent seed. Therefore the licensed seed producers are allowed to rear the remainder of the parent worms under the supervision of the Controlling Stations (*see* Sections 29 and 49). The mother-moths and egg cards of the common seed (Fig. 4) have to be submitted to the examining stations where the moths are examined for pebrine and the egg cards passed with a stamp. No egg card which does not bear this authorised stamp can be sold. There are about 8,000 licensed egg producers and more than 40,000 persons engaged in the sale of these eggs. The seed-traders are also licensed.

Eggs require to be kept in cold storage for about three to six months. Most of the seed producers have their own cold store. In some places there are co-operative cold stores and in the absence of other arrangement the cold store of the Experiment Stations is allowed to be used at a nominal charge of 3 sen per egg card. The rearers arrange for their eggs either direct from the egg producers or through egg card brokers.

Some of the large reeling factories, *e.g.*, Katakura and Gunze, have their own egg-producing stations where they carry on a certain amount of research work also for finding suitable races of worms. They thus assure themselves of the supply of a



Fig. 3. A fairly recent medium tree plantation pruned for use in May-June.

Fig. 4. An egg card with the eggs of 28 moths. Five of the layings contained 688, 571, 584, 368 and 695 eggs.



Fig 5. Ordinary method of rearing worms on trays kept in shelves in houses. Leaves are being supplied on a tray.



Fig. 6. Worms are made to spin cocoons among folded paddy straw on trays. In this figure cocoons are being removed from the straw.



Fig. 7. *Josso-iku* method of rearing. Entire branches bearing leaves are being supplied.



Fig. 8. *Josso-iku* method of rearing in a large godown. Frequently cultivators arrange for rearing in a similar manner in their houses.

uniform kind of cocoons. They claim they have superior races and take care not to allow these races to go out of their sphere.

3. Rearing of worms.

Rearing of worms is done generally indoors in the ordinary manner on trays which are arranged on shelves (Fig. 5). The temperature is regulated by the use of a fire kept in a pit in the floor about the middle of the room.

The appliances used are made of bamboo and straw. The trays are usually open-meshed bamboo trellises, about 3 feet × 2 feet, on which a matting of straw of the same size is placed. This matting is made by stringing straw in the same manner as bamboo *chiks* (blinds) and it can be rolled up and kept away. Flat bamboo mats are also used as trays. Larger trays, up to about 6 feet × 4 feet, are sometimes used. For spinning of cocoons generally straw is folded up with the help of a machine and arranged on ordinary trays (Fig. 6). In the young state the worms are kept on paper spread on the trays.

Lately a method of rearing called *josso-iku* (Figs. 7 to 9) is being followed extensively and encouraged. Worms in fourth and fifth stages when they eat voraciously and require a large space, are not in this method kept on trays. Whole branches of mulberry are cut and supplied. As the leaves are eaten, fresh branches are placed on top. The old branches are not removed. The bed therefore may be one to two feet high. This method of feeding is followed both indoors and out of doors, under trees or even in open places. Climate and absence of parasitic flies enable this method to be practised. It is claimed that the cost of rearing is lessened by about 10 per cent. as the bed need not be changed and the leaves need not be plucked. It is also claimed that there is saving to the extent of about 10 per cent. in leaves as the leaves do not dry up so quickly as when plucked off from the branches. More than half of the rearing is said to be done in this method at present.

4. Races of worms. (Fig. 10).

About one thousand varieties of silkworms are in existence in Japan. In former times rearers reared whatever races they liked and therefore cocoons collected from a particular area consisted of several kinds. This was a serious drawback in organised reeling. Uniform cocoons are required to produce a uniform kind of raw silk. The work done by the Imperial Sericultural Experiment Station in unifying the races of worms has been referred to under Research and Experiment. (Section 43).

At present the major portion of the rearing is done with F_1 crosses between Italian, Chinese and Japanese races. The Chinese and Japanese races in use have been purified for the purpose. The foreign races are maintained in Japan but large quantities of eggs are also imported every year to maintain their vigour. In 1927 about 68,000 ounces of eggs of Italian races were imported.

Only some varieties have been selected for crossing purposes and out of these again different varieties are used as found suitable in different localities. The

commonest ones are Italian 0, Japanese *Nichi* 1, and Chinese 4, 5 and 7. These are all univoltine and their F_1 crosses (*Nichi* 1× *Shi* 4, *Shi* 4× *Shi* 5, *Shi* 7×07, *Shi* 4×07) are almost wholly (about 99·5 per cent.) reared in spring. Three new varieties K1, K2, K3 have recently been evolved and fixed at Nakano and the Imperial Experiment Station has high hopes of them.

For the summer months, when the temperature is high, bivoltine races are used and, as in the case of the univoltine ones, some races have been specially selected. The commonest ones are Japanese *Nichi* 107 and 110 and Chinese *Shi* 102, 105 and 107 and their F_1 crosses (*Shi* 105×*Nichi* 107, *Shi* 105×*Nichi* 110, etc.), are reared to the extent of about 80 per cent. of the total rearing of this season. Triple crosses, such as *Nichi* 107× *Shi* 101× *Shi* 4 and crosses between uni- and poly-voltines are also used but on a small scale.

Both in summer and autumn and especially in autumn when the temperature is low, univoltine races are also reared, the eggs being made to hatch with hydrochloric acid treatment.

Other indigenous races are reared here and there though on a small scale. I came across the following, *viz.*, *Matamukashi*, *Aojiku*, *Sanjuran*, and a few others.

As regards colour, white cocoons are preferred as white raw silk fetches a higher price. Yellow cocoons are not considered good in summer and autumn. In 1927 yellow cocoons formed about 40 per cent. of the spring crop. Yellow varieties are European×Chinese crosses and white varieties are Japanese ×Chinese crosses.

Univoltine eggs are laid in June and hatch in May next year. The first generation of bivoltine eggs hatch in May and after going through a cycle the second generation lays eggs about the middle of August; these overwinter and hatch in May next year. The eggs are kept at the ordinary temperature till about December and then placed in cold storage at a temperature of 40° F and are taken out and incubated about the middle of April. Univoltine eggs are best incubated at a temperature of 25° C (about 77°F) and the bivoltine ones at 15°C (about 59°F). The eggs of the bivoltine races then hatch in the next generation without hibernation and with incubation at a temperature of 70°F to 80°F.

5. Seasons for rearing.

There are two principal seasons for rearing. One is in spring, *i.e.*, May (about middle) to June (about middle), when the best cocoons are produced. The other is called the summer rearing which in some places may be divided into actual summer rearing in July, ending about the beginning of August, and late Autumn rearing in August, extending to September or even to early October in limited localities. This late autumn rearing is coming into vogue when on account of low temperature better results are obtained than in summer. The majority rear two crops of cocoons in a year and only some three crops. This is controlled by the supply of leaf. From the mulberry used in spring rearing a crop of leaves is taken in autumn. For summer



Fig. 9. Rearing worms in the open.

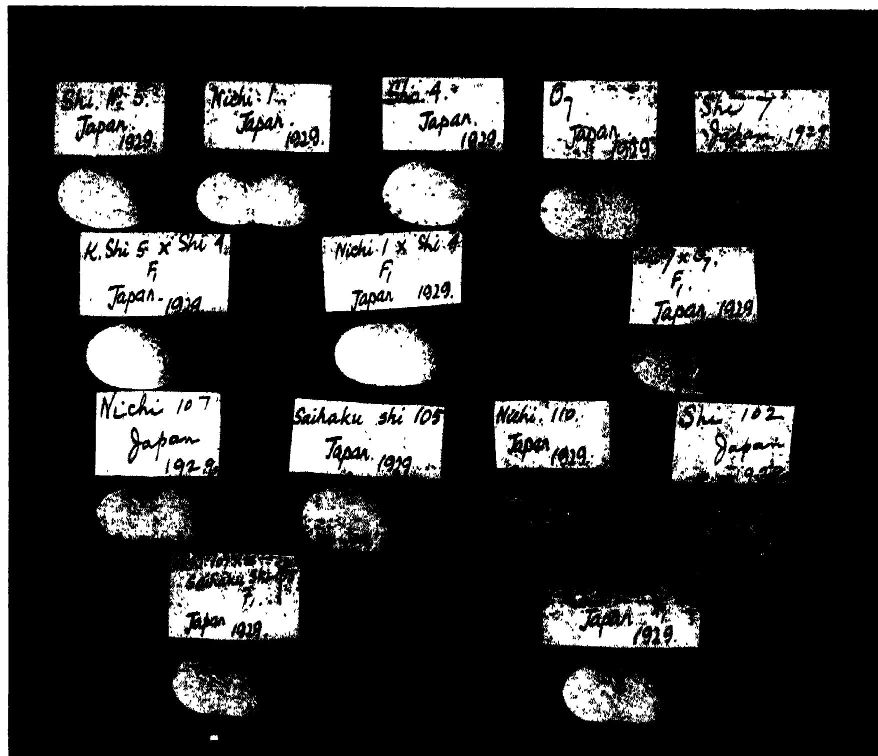


Fig 10. Cocoons of parent worms and first generation F_1, cross worm—Shi means Chinese, Nichi means Japanese, and O is Italian. Numbers below 100, such as 4, 5, etc., indicate univoltine or one brooded races and those above 100 such as 102, 105, etc., are bivoltine races. Cocoons O_7, Shi 7 and Shi 7 × O_7 are yellow and all the rest are white.

rearing mulberry has to be treated differently without taking a spring crop. To harvest two crops of leaves is considered injurious. Therefore attempts are being made for having mulberry separately for different seasons of rearing. About twenty-five years ago the summer or rather summer-autumn crop of cocoons formed about 30 per cent. of the yearly total crop of cocoons. But with improvement in methods the summer crop has increased and at present is equal in volume to the spring crop, which also has increased in volume. The factors contributing to the improvement of the summar rearing are the following :—

(*a*) Improved worms evolved through selection. and hybridization and also rendered available through artificial systems of forced hatching.
(*b*) Improved methods of rearing.
(*c*) Control of temperature through devices in rearing houses.
(*d*) Improved food due to improved varieties of mulberry and improvements in cultivation and manuring.
(*e*) Rearing in late autumn when the temperature is low.

6. SALE OF COCOONS.

Cocoons are disposed of by the farmers in one of the following ways.

(1) The farmer sells individually to brokers or agents of filatures at his own house.

(2) The farmer takes the cocoons to (*a*) the broker's place, (*b*) a filature or (*c*) an auction market. (*a*) At the broker's place the broker (i) either acts as a middle-man when the buyers and sellers haggle and settle the price and pay ·8 per cent. as commission to him or (ii) himself purchases and then sells the cocoons. The general opinion is that brokers in such cases resort to bad practices and pass bad cocoons with good ones.

(*b*) Filatures in some cases maintain purchasing centres in different places. They may carry out a preliminary reeling test before completing the transaction.

(*c*) At auction markets cocoons are sold to the highest bidder. Such markets are run by various agencies. One Joint Stock Company at Yorii charges 30 sen per 100 yen from the farmers and 1·5 per cent. from the purchasers up to a purchase of 5,000 yen and progressively smaller per cents. on purchases of higher amounts.

The cocoons are poured on a broad wooden table with raised edges. The clerk of the agency sits on one side and cocoon examiners on behalf of the purchasing filatures sit on the other. Each examiner examines the cocoons with sight and feel (rarely chewing them) and puts down his bid with chalk on the inner side of a metal saucer which is passed in inverted position to the clerk. After all the bidders have noted down their bids in this manner, the clerk turns up the saucers and declares the highest bid which secures the lot. The examiners carry out yield tests on a day's purchase and are thus able to gauge their offers correctly.

When the cocoons have to be sent to distant filatures they are dried to 50 per cent. at a charge of 35 *sen* per *Kan*. Then they are put in cloth bags of 32 gallons capacity

and the bags inside wide-meshed cane cases which are despatched by rail to filatures. The cane cases prevent the cocoons from getting crushed. (Fig. 11).

(3) Rearers' societies and guilds have large quantities of cocoons for sale and usually deal directly with a filature which carries out a yield test before purchase.

(4) The recent development is sale through co-operative drying societies. Government is encouraging and subsidising these in order to foster the trade in dried cocoons. The Co-operative Cocoon Drying Society of Osato County receives, dries and sells the cocoons of the members. The only charge made to the members is 25 *sen* per *Kan* of green coooons for drying. On sale ·8 per cent. is charged to the purchasers. The storage charge is 3 *rin* per *Koku* (about 40 gallons) per day paid by the filatures which purchase the cocoons but leave them in the custody of the society until payment is made.

When a member brings in his cocoons they are poured out and a sorting carried out. The defective and flimsy cocoons are picked out and given back to the rearers. Then the cocoons are weighed and a lot, 400 *momme* in weight, is sent to the Kumagaya Experiment Station for testing. The cocoons of different members are then mixed up and treated as necessary and payment is calculated according to the results of the tests.

7. Price of cocoons.

The price of cocoons is determined by the quotations for raw silk in the Yokohama Exchange. Quotations for cocoons are described as *Kake* or *Kakeme* which means the price in yen of that quantity of green cocoons which will produce one *Kamme* (also called *Kan*=1,000 *momme*=8¼ lbs.) of raw silk. The average yield being one-tenth, *Kakeme* indicates the price of ten *Kan* cocoons at this rate of yield. To take an example, suppose the quotation at Yokohama Exchange is 1,350 yen per bale of raw silk when autumn cocoons are offered for sale. One bale is equal to 16 *Kan* or 100 *Kin*. The expenses for reeling and other incidental charges in the production of raw silk are calculated at a standard rate of 350 yen per bale in the case of autumn and 300 yen in the case of spring cocoons. By deducting 350 yen from 1,350 yen and dividing the remainder by 16 we get 62·5 yen which is the price of one *Kan* raw silk or ten *Kan* cocoons which will produce this quantity of raw silk if their yield is one-tenth of their weight. The *Kakeme* is 62·5. In order to make allowance for superior and inferior cocoons *Kakeme* connotes that if the yield is more or less than one-tenth, the price will vary accordingly. If the yield is 12 per cent., the price will be $\frac{62{\cdot}5 \text{ yen} \times 12}{10}=75$ yen for ten *Kan* cocoons. If the yield is 9 per cent., the price will be $\frac{62{\cdot}5 \text{ yen} \times 9}{10}=56{\cdot}25$ yen for ten *Kan* cocoons.

As regards the age of cocoons at the time of transaction for sale, the general practice is to bring for sale spring cocoons on 7th or 8th day and autumn cocoons on 5th or 6th day. Cocoons with younger pupae weigh more and if by general examination they are observed not to have developed to this extent, weighment is delayed.



Fig. 11. Cane work cases for despatching cocoons by rail (After C. J. Huber).



Fig 12. Teguri-kikai or hand reel.



Fig 13. Reeling practised in Karen Hills, Leiktho, Toungoo district, Burma.

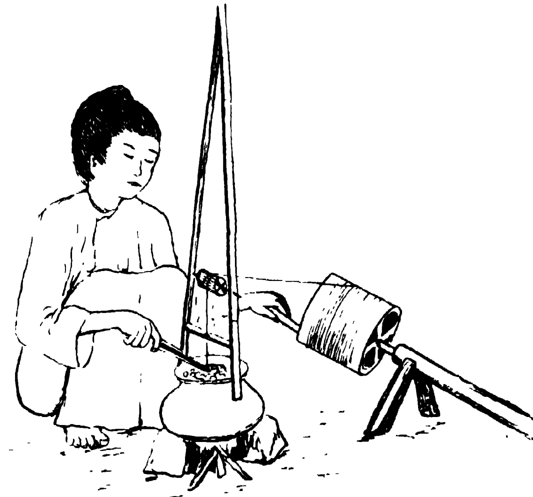


Fig. 14. Reeling practised among Yabeins in Prome district, Burma.



Fig. 15. Zaguri-Kikai or Sedentary reel.



Fig. 16. Ashi-bumi or treadle reeling machine. The lower smaller box is simply a support to raise the oven box.

PART II. THE REELING INDUSTRY.

8. Reeling Machinery and Method of Reeling.

The evolution of the reeling machine and necessarily of methods of reeling is briefly described below.

(1) ***Dotori-kikai**** or frap-reel was the primitive machine. It was a cylindrical piece of light wood 2 feet long and about 5 inches in diameter, fitted with an axle supported on a stand about 6 inches high. The reeler gathered 5 or 6 filaments and twisted them between her palms and then wound the thread on the reel by frapping it with the hand. Reeling was therefore not continuous. One thread was reeled at a time. It does not exist anywhere at present.

(2) *Teguri-kikai* or hand reel (Fig. 12) was a more improved form of the above. It consisted of a rectangular reel with a circumference of about 2½ feet and fitted on a stand. The reel was turned with a stick held in one hand and the other hand twisted the filaments. A single thread was reeled at a time. It is not in use anywhere now.

(3) *Za-guri-kikai* or sedentary reel (Fig. 15). In one form the reel is turned by toothed wheels (*Zyo-za-guri*) and in another form (*Oshiu-za-guri*) two wheels and a belt are used. The fittings are (*a*) a bamboo stick distributor, (*b*) folded hairs through which the thread passes, (*c*) a V-shaped brass wire and, (*d*) a rectangular reel with circumference of 1 foot nine inches. Cocoons are boiled in an enamelled pan on a charcoal oven and the machine is placed by the side of the pan. The reel is turned with one hand and the cocoons are manipulated with the other. This machine is in extensive use for reeling defective waste cocoons and double cocoons. A single thread is reeled at a time but in some forms two threads.

(4) ***Ashi-bumi*** or treadle reeling machine (Fig. 16). It is a simplified form of the reeling machine imported from Europe. Two threads are reeled at a time and the croissure is the Italian Kennel system. This machine is in extensive use yet. A charcoal oven is fitted to the machine which can be placed or moved about wherever convenient or desired. An enamelled pan is used for boiling the cocoons.

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* Compared with the *dotori-kikai* and *teguri-kikai* of Japan the primitive methods still followed in Burma are interesting. Figure 13 illustrates the method followed in the Karen Hills, Leiktho, Toungoo District. Cocoons are boiled in an earthen pot over fire and manipulated with a pair of iron tongs. The thread passes through a hole in a horizontal bamboo strip above the boiling pot and then over and round a bamboo wheel and is pulled with the left hand and placed on a bamboo tray. Afterwards it is rolled up into a ball several inches in diameter with hand. The bamboo strip and wheel are fixed on two upright bamboo supports which stand astride the mouth of the boiling pot and are secured together at their upper end by being tied on a beam in the thatch of the house.

Fig. 14 shows practically the same method but slightly advanced, there being a wooden block which is turned with the left hand to wind the thread on it.

(5) The filature machine (*kikai*) (Figs. 17 to 20) introduced from France in 1870 and modified and improved in various ways. Each reeler reels 5 to 6 threads at a time ordinarily, but even up to 20 threads are done according to make of machine and skill of the reeler. The process is a double one ; the thread is at first reeled on to a small reel about 2′ in diameter (reeling) and then to a large standard reel 59 inches in diameter (re-reeling). In the majority of cases reeling and re-reeling are carried out in the same establishment. In some cases re-reeling is carried out separately. There is direct connection of water and steam to the china-ware reeling basin (Fig. 17). The reels are turned by electricity practically universally at present. Steam heat is arranged for with pipes in order to dry the silk being reeled and re-reeled.

At present there are four kinds of reeling producing four different kinds of thread (*ito*), *viz.*:—

(1) Hand reeling producing thick coarse thread (*Zaguri-ito*) from defective waste cocoons.

(2) Foot reeling producing good thread (*Ashibumi-ito*) from good cocoons but from the nature of the machine used production of a uniform thread on a large scale is not possible.

(3) Filature (*Kikai-ito*) reeling with up-to-date machinery.

(4) Dup'on or double cocoon reeling (*Tamaito*).

About 1898 the first and second kinds accounted for about 50 per cent. of the raw silk production in Japan, but by 1927 they dwindled down to about 4·5 per cent. Double cocoon reeling is a recent development but at present there are about 35,000 basins working at it and cocoons are even imported from China. In 1927 dupion silk was about 6 per cent. of the total raw silk production.

The first two kinds of thread are not exported now but utilised for weaving at home. Even of the filature silk, that which falls below certain tests is not exported because the market in America is very particular about quality and demands certain specific standards. Dupion silk, like waste cocoons and waste silk, is really a by-product and although coarse is being largely exported to India at present especially on account of its cheapness.

About 90 per cent. of the raw silk is reeled in filatures with modern machinery. The demand in America is mostly for two sizes, *viz.*, 13-15 denier and 20-22 denier, and to a less extent 14-16 denier. For 13-15 denier silk 5 to 6 cocoons and for 20-22 denier silk 7 to 8 cocoons are required to be passed on to the thread. According to the races of worms usually a fixed number of cocoons, 5 and 7, are reeled to get the desired size.

The present Japanese filature machine, which is really a modified form of the European, is simpler than the French and Italian ones and much less costly. With wooden parts each unit basin is quoted by makers at 70 yen and with brass parts 170 yen. Several filatures were observed to have special parts which they claimed

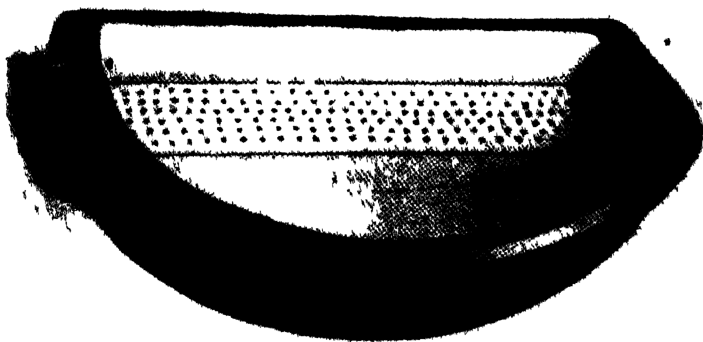


Fig. 17. Common type of China ware reeling basin

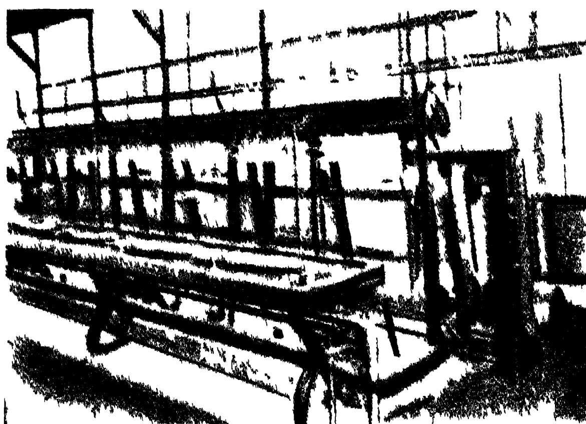


Fig. 18. Details of common filature machinery. Basins are fixed on a table. The small reels rotate above and behind the reeler under a sort of concave roofing containing heated gas pipe.



Fig. 19. A filature. The reeler girls at work sitting.

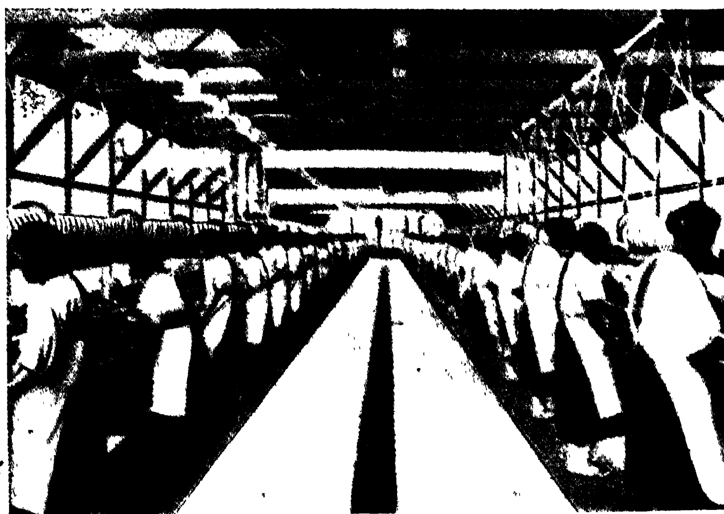


Fig. 20. An improved type of filature (Minorikawa) each girl doing 20 threads at a time and reeling while standing

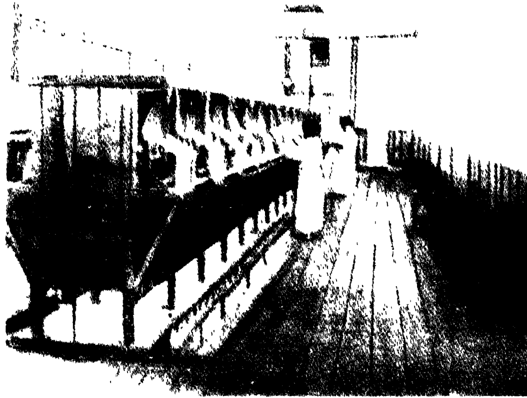


Fig. 21. Re-reeling. The small reels from the reeling machines are placed on the ground on one end and the thread drawn off.

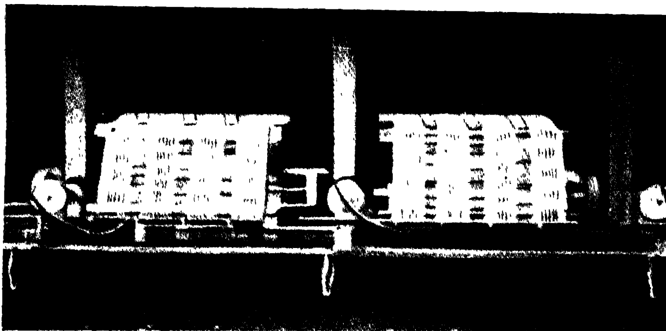


Fig. 22. Diamond crossing of the thread in the hank.



Fig. 23. Steam drying chamber (Obi-kawa system).

to be their own patent. For instance, in one a spiral wire fitted to a revolving cylinder in place of the button seemed to be very efficient and easy for joining fresh filaments. Even a novice could carry on reeling easily. In another filature the filaments first of all passed over a dent of a brass plate which rubbed off small impurities, nibs, etc., before passing through the button. In a third, called Choko's system, the filaments passed through rather close-fitting wires for the same purpose and joining of fresh filaments was arranged for with a toothed wheel.

In *zaguri-ito, ashibumi-ito* and *tamaito* the cocoons are cooked on the reeling pan by the reeler. In filatures, cocoons are cooked separately (*see* cooking of cocoons, Section 36). In some types of filature there is an automatic brushing arrangement for finding the ends; in some a separate endfinder girl is engaged who can serve about six reelers; still in some others a girl is engaged to knot breakages and one such girl can serve about seven reelers. After knotting, the loose ends are cut off with the teeth. In most filatures the reelers do brushing, reeling and knotting themselves and work while sitting on a stool. In some they have to remain standing all the time.

9. Re-reeling.

The small reels from the reeling machine in all forms of reeling are taken to the re-reeling plant. Their corners are wetted by beating them with a wet cloth and they are placed on the floor on one end and the thread reeled on to a large reel, 1½ meters or about 59 inches in circumference (Fig. 21). The thread is arranged on the large reel in a diamond crossing and is known as grant reel (Fig. 22). Steam heat is arranged in the re-reeling plant for drying the silk. Before being taken off from the re-reeling frame the hanks of all exportable silk are laced at two opposite places with cotton string. After being laced the hanks are removed from the reel and taken to the hank-twisting and dressing room. While being re-reeled a record is also kept of the number of breakages. Hanks which have more than five breakages are not exported.

10. Organisations for reeling.

Before the export trade of raw silk came into existence on the opening of the Port of Yokohama about the middle of the last century the rearers were their own reelers and of the simple types of reeling machines they used the *Zaguri* or sedentary machine is still used for certain purposes. Home reeling is hardly practised now by the rearers who, as a rule, sell their cocoons as soon as formed. It is however still practised by a different class of people in the following manner.

The waste cocoons (*i.e.*, flimsy, stained and crushed ones) are purchased by many women and reeled on the *Zaguri* into a coarse thread. The work forms a subsidiary home industry (Fig 15).

Home reeling with the foot-reeling machine (*Ashibumi* Fig. 16) is still practised on a large scale in many districts and the number of these machines in use in 1927

was about 105,000. More than 80,000 factories, returned in the statistics for 1927 as having less than ten reeling basins, are really households who keep a few of these machines and either do the reeling themselves or engage girls to do it. One form of this home reeling industry is what is called *degama* which means " sending out cocoons to out-side reeling basins ". Cocoons are purchased, dried in simple drying chambers, stored in large zinc vessels and distributed to different houses for reeling. The owners give charcoal at the rate of five *kan* (or about 42 lbs.) for four reeling basins per day and 8 sen cash for every 10 *momme* of reeled silk. They have a simple re-reeling plant in their house, heated by a charcoal fire placed at the bottom of the re-reeling frame, and the silk in the small reels is brought here and re-reeled.

A step higher than the *degama* are small reeling factories with modern machinery. I came across one man who had developed a 20-basin factory from *degama* at Katsuyama in Fukui Prefecture. His capital expenditure for the house, reeling plant, boiler, etc., was 7,000 yen. Besides the 20 reeler girls he had 6 other hands for drying, cooking, boiler, pump and re-reeling plant. Each reeler girl was paid 1 yen per day without food.

Large factories belong to co-operative Societies, Companies and Corporations. The following is a short account of a 42-basin co-operative reeling factory at Kamyakuno village in Ayabe Township of Kyoto Prefecture. Six-hundred-and-fifty rearers subscribed 70,260 yen for 2,342 shares at the rate of 30 yen per share. The buildings and plants cost 50,000 yen. Out of the cost of the cocoon store 40 per cent. was contributed by the Government. There is a small raw silk testing laboratory. The reeling plant is of a cheap type costing at the rate of 70 yen per basin.

All the members are required to bring all their cocoons here to be reeled and receive payment after the silk is sold. The cost of reeling and incidental charges are deducted from the price and they amount to about 1·20 yen per *kan* of cocoons. No dividend is paid or expected, the members remaining satisfied with the higher price they actually get for their cocoons.

There is another type of large co-operative reeling organisation in which the daughters and wives of rearers themselves do the reeling of their own cocoons and the resultant raw silk is sold by the organisation, which deducts ten yen per *kan* of silk for the use of the factory and charges incidental to sales. These co-operative organisations originated as raw-silk marketing societies when home-reeling was practised by the rearers and later on adopted reeling with machinery. At present in some parts of some of them reeling is carried out on the factory system with paid labour in order not to let the machinery remain idle when the farmers' daughters and wives are engaged otherwise. They embrace whole prefectures and are subsidised and supervised by Government for the benefit of the farmers. The one for Saitama Prefecture is known as Saitama Sha with about 8,000 members. It is composed of forty component co-operative reeling societies located in different parts of the Prefecture and has 2,500 basins. One component society at Yorii is used as a training

school to which the daughters 15 to 18 years old and even older relatives (up to the age of 40 years) of members of component societies are brought, accommodated, fed and trained for one year. The expenses are met partly by the organisation and partly by the members themselves and Government contributes 1,000 yen per year.

The similar organisation of Nagano Prefecture has 43,000 members and operates 8,600 basins.

All efficient reeling factories or filatures are large concerns. A brief history of the Gunze Filature of Ayabe will be interesting. About 1886 a sericultural association was started mainly with the idea of improving sericulture. In 1896 the Gunze Raw Silk Manufacturing Co., Ltd., was started as a joint stock company with a capital of 98,000 yen (20 yen per share) and a factory of 168 basins. With the increase of production of cocoons in the country the capital and basins were increased and the company arranged for producing eggs for their cocoons. In 1927 they had 20,666,600 yen as capital (11,716,625 yen paid up), 5,989,011 yen as reserve, 27 factories and 4 branch factories with 8,414 basins, employing 12,000 women and 2,000 men and produced 30,000 bales raw silk (bale=133·3 lbs.), 16,000 bales dupion silk, 120,000 *kan* waste silk (Kan=8¼ lbs.) and 350,000 boxes of eggs. They maintain a school for training reeling factory mechanics, reelers and reeling supervisers. The conditions under which the factory labourers are housed and looked after are ideal. There is a hospital in every mill, training courses for nurses and arrangements for regular physical exercise. The general and moral education of the factory hands is also looked after.

Gunze filature ranks second as regards the number of basins. Katakura Filature concern is much larger and operates about 20,000 basins and has mills and branches in many places in Japan and also in China.

The development of reeling from a home or cottage to a factory industry has led to cheap mass production by machinery, better care and treatment of cocoons and uniformity and improvement in quality of the raw silk. The produce of a small factory takes long to come up to a ten-bale lot, the minimum exportable quantity. According to experts factories with less than 100 basins are uneconomical and the most economical number is 300 basins. Therefore amalgamation of smaller factories is advocated. As a matter of fact, small factories are steadily decreasing, as will appear from the following figures :

Year	Factories with						
	less than 10 basins	10-50 basins	50-100 basins	100-300 basins	300-500 basins	500-1,000 basins	over 1,000 basins
1908 . . .	3,86,996	3,968	645	405	*Nil*	*Nil*	*Nil*
1917 . . .	2,65,466	2,448	1,026	796	*Nil*	*Nil*	*Nil*
1922 . . .	2,04,311	1,696	854	683	114	71	9
1927 . . .	80,034	1,734	875	707	128	82	8

11. Factory hands.

In 1927 the reeling factories, 83,568 in number, employed 462,594 women and 33,335 men. The majority of the women are reeler girls of the age of about 15 to 19 or 20. They come after completing the compulsory primary course of education and work for about one to three years and then go back and marry and settle down in life. About 20 per cent. stay for one year and about 60 per cent. for about three years. Only a small number stays longer or shorter periods but cases are known when one has been working for as long as 30 years. About 80 per cent. of the girls live in lines provided by the factories. In Japan not only in this but in all kinds of industries the practice is to supply food to the workers. The condition of the factory lines generally is very satisfactory. Excluding food on the average a reeler girl in 1929 received about 75 sen a day, the maximum in some cases being nearly 2 yen a day. The hours of actual work are usually 11 hours and in some cases 10. There are systems, sometimes elaborate, for fines and rewards for the quality of the silk reeled, the quality in this case indicating uniformity of thickness or denier.

12. Operations in a reeling factory.

The work of a reeling factory consists in (1) purchasing, (2) stifling, (3) drying, (4) storing, (5) sorting cocoons, (6) actual reeling and re-reeling, (7) testing of the raw silk, (8) dressing and packing of the raw silk and (9) despatch for sale.

Purchase and stifling, *i.e.*, killing the pupa inside in order that moths may not cut out and spoil cocoons, have already been referred to in Section 6.

13. Drying of cocoons.

Drying is done with dry heat either from fire or steam. The latter is preferred and is mostly used at present. The following methods are common :

1. The simplest contrivance for using fire is to have an enclosed chamber with (1) a pit at the bottom for burning charcoal, (2) a screen above the fire, say a sheet of iron or tin, (3) shelves for keeping the cocoons in thin layers, (4) pipes like chimneys to let out the evaporated moisture at the top, and (5) inlet pipes for fresh air to come in somewhere near the bottom. The walls of the chamber may be of brick, mud, wood, iron or tin. These are in use by those who are still carrying on reeling on a small scale as a home industry. Stifling can be done in these chambers in about half an hour but drying takes about 20 to 24 hours.

2. Large chambers for use with fire have floors fitted with iron-pipes which are heated with coal or wood fuel through a regular fire place and with a proper brick or iron chimney, 30 or 35 feet high and also with outlets for evaporated moisture. A few small factories have such drying chambers which are, however, going out of use. There are arrangements for rotating the shelves of cocoons while being dried or a fan is worked inside the chamber below the outlets for the evaporated moisture. Drying is effected in about 8 hours.

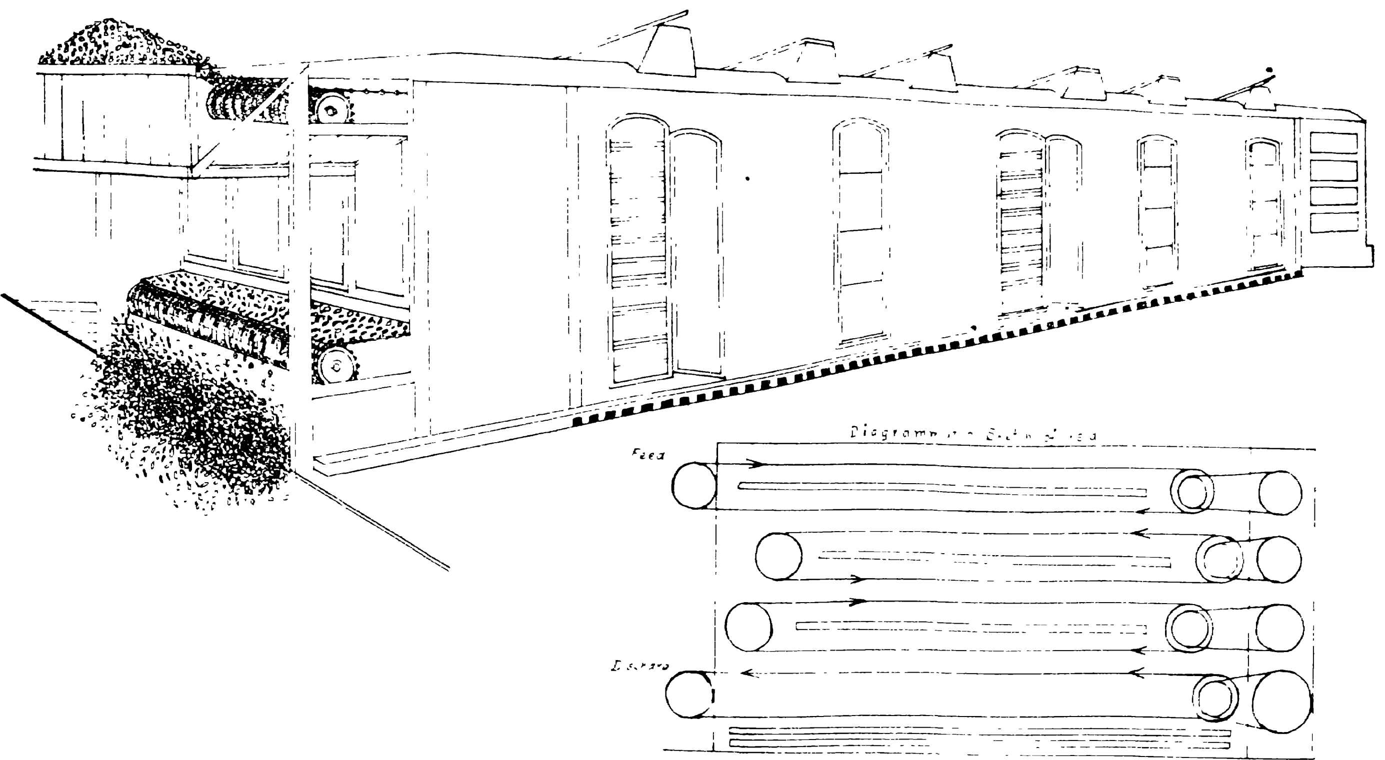


Fig. 24. Imamura plant for continuous drying of cocoons. (Diagrammatic sketch.)

3. The chambers (Fig. 23) most commonly used are what are known as of the Obikawa type. They are heated by a series of steam pipes in the floor and a fan is worked below the chimney or outlet for evaporated moisture. The cocoon trays are placed on shelves in a frame which can be pushed out or in on iron rails. The door is of double walls of wood with about three inches of saw-dust inside. The walls are usually of brick but may be of the same construction as the door. Bent thermometers are fitted on the door and can be read from outside. With temperatures inside varying from about 175° to 200°F drying is complete in about 8 hours.

4. The Imamura plant (Fig. 24) for continuous drying with steam is in use in practically all large factories. The cocoons are fed at the top in a thin layer on a slowly moving endless wire-cloth which spreads in several folds inside the plant and come out at the bottom ready dried in about six hours. This plant is being adopted by all those who can afford it.

14. Storing of cocoons.

The dried cocoons are stored in various ways. The simplest is the method of storing them in tin or zinc vessels with tight fitting covers. In large scale storing they are put in bags of thick moisture-proof paper and these bags are heaped in store houses which are large buildings three or four storeys high and with large rooms, about 20′×20′×14′. The modern store-houses are re-inforced concrete buildings which are fire-insect- and rat-proof and are lined with zinc sheets throughout. In some cases the inside chambers are of wood but lined wholly with similar metal sheetings. There are arrangements for regulating the humidity inside with the help of adosal plants which are worked if the humidity rises beyond 70 per cent.

15. Cold storage of cocoons.

Instead of drying the cocoons a new method of keeping them in cold storage at a temperature of about minus 5°C to 10°C has recently been evolved. It is claimed that cold storage treatment in this manner does not affect the quality of the filament as heating does and further, reeling is easier. Up to now cold storage treatment has been adopted partly in the Maebashi Co-operative Filature (Gumma Sha) where the cocoons are dried about half and then stored in the cold store, which is a large building, and the low temperature, about 0°C to —10°C, is obtained and maintained by an ammonia compressure plant (Rushton, Lincoln, England).

At Matsumoto a filature has set up a five-storey cold store worked with an American ice machine (Campbell, Halifax). The raw cocoons are placed directly on the shelves in the store-house without any sort of treatment. Handling of the cocoons into and out of the store house is carried out with the help of an inclined belt elevator.

In both places it was claimed that the cocoons were in a good condition even after one year. Cold storage in this manner is said to cost about the same as drying and storing in the prevalent method as well as in respect of equipment and building.

16. Sorting cocoons for reeling.

In order to be able to produce high-class uniform raw silk reeling factories take good care in sorting the cocoons.

First of all spring, summer and autumn cocoons are kept and reeled separately. Secondly, the cocoons of different areas of production are similarly dealt with on account of the subtle effects of climate and food.

Thirdly, the cocoons of different breeds are kept separate as far as possible. Unification of breeds practically all over Japan has minimized difficulties on this account.

The next step in order to obtain good results is to eliminate defective cocoons, *viz.*,

(1) Dead cocoons, in which the worm has died and in rotting has soiled the inner layer. Figure 25 shows a simple device. The surface of the table is black and it is wholly covered with a black cloth. A piece of ground glass about one foot or 1′ 3″ square is fitted into a hole cut in the surface of the table and flush with the surface. Below there is a mirror by which light is reflected from a window. In order to get a better light there is sometimes a wooden enclosure blackened inside and open on top behind the window. Electric light is used in large factories, a table and electric lights below it being sufficient.

(2) Flimsy cocoons.

(3) Dupions or double cocoons.

(4) Spotted cocoons, which are not wholly soiled as in (1) but in which a brown or black spot is seen on account of some secretion from inside.

(5) Crushed cocoons.

All these are separated by sight. In large factories the cocoons are placed on broad endless moving belts and the defective ones are picked out by girls as the cocoons pass by them.

Small cocoons are sorted out by passing the cocoons through a frame, usually of bamboo with holes. Small cocoons drop through these holes. They are not really defective but they interfere with reeling speed and cause unevenness on account of the shortness of their filament and are therefore reeled separately.

Defective cocoons form about 5 to 8 per cent.

Sorting according to reeling quality. The use of ultra-violet rays in sorting cocoons regarding their reeling quality is said to be coming into vogue. Experiments with quartz lamps were first of all carried out by Dr. Inouye and his associates at the Ueda Sericultural College. They showed that white cocoons giving yellow fluorescence reeled well, that is, were reeled in the shortest time and yielded more raw silk. White cocoons with violet fluorescence reeled badly and those with fluorescence intermediate between yellow and violet gave intermediate results. Similarly yellow cocoons with bright yellow fluorescence reeled well but with dark violet

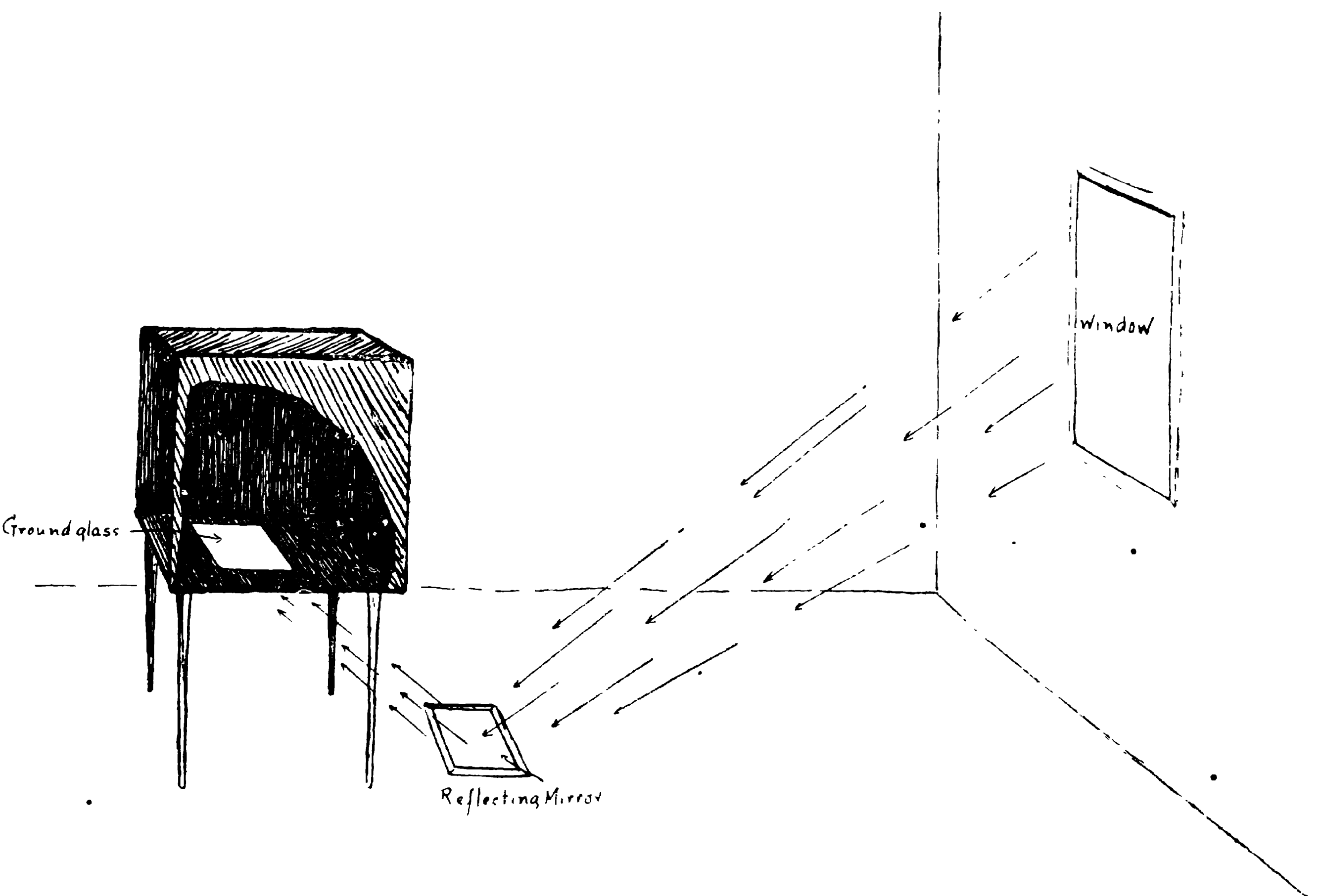


Fig. 25. A simple device for sorting cocoons with reflected light.

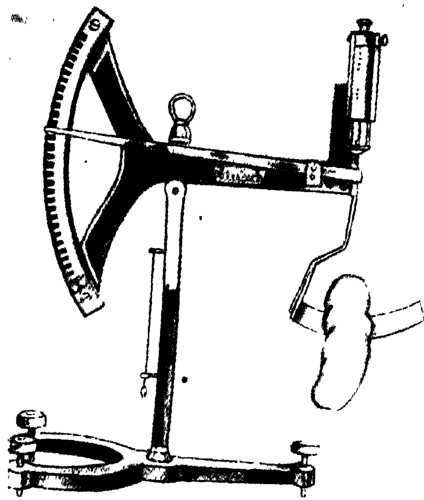


Fig. 26. Hank weighing balance.



Fig. 27. Book-making machine

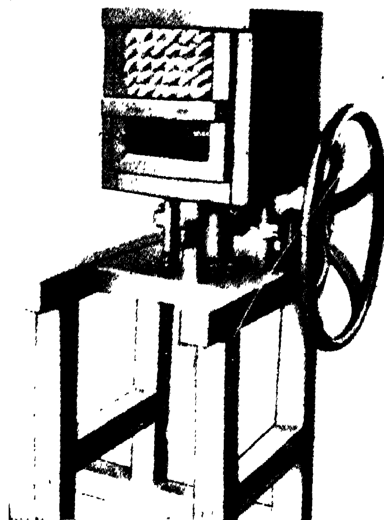


Fig. 28. Book-making machine.

fluorescence reeled badly. The process is quite simple and it is only necessary to sort out the cocoons with a mercury quartz lamp in a dark room. A few filatures are said to have adopted the method.

Dr. Inouye has also evolved a chemical test and already patented and placed it on the market. It consists of several series of liquids with different tints in sealed glass tubes. A cocoon is cut into two pieces and the outer and inner layers of a piece ·1 gramme by weight soaked separately in test tubes for 30 minutes at about 20°C in a solution made up of 5 c.c. of ·2 per cent. sodium hydrate and 1 c.c. of ·1 per cent. copper sulphate. The tint which this soaking imparts to the solution is then compared with the standard tints supplied to find out the reeling quality. This test can only be applied to lots and cannot be used in actual sorting.

17. Reeling and other operations.

The cocoons are cooked (*see* cooking of cocoons in Part IV, Section 36) in small *lots* (usually 120 *momme* or 15¾ ounces) and placed in small wooden tubs which are carried to the reeler girls. The reelers reel 4, 5, 7 or 8 cocoons into a thread according to instructions given. The reeled thread then goes to the re-reeling machine for being re-reeled and a paper ticket accompanies it on which the number of the reeler girl is noted. While being re-reeled a test sizing skein 225 meters long is taken from it and also a record kept of the number of breakages, hanks with more than five breakages not being considered good for export. It is then made into a hank. The hank and its test sizing skein are then weighed (Fig. 26). The weight of the hank and its size (thickness of the thread) determined from the test sizing skein are entered in the ticket. The weight of the hank is usually 2·4 ounces and the quantity of cocoons to be given to reelers is determined accordingly. The hanks varying in size widely are separated as it is desirable to have uniformity in size of all the hanks of a lot. The hanks then go to the inspection place where uniformity is required in colour and lustre and here, in addition to these, the inspectors claim to determine by means of touch and sight the nature, nerve, strength, elasticity and cohesion. In some places the hank while still on the re-reeling frame is examined in the visual inspection place. The aim is to have the hanks sorted into uniform lots. Thirty hanks are then packed and tied into a bundle called a " book " (Fig. 29) with the help of a pressing machine (Figs. 27 and 28). Great care is taken in the formation of the hanks and the books so as to give them a uniform and tidy look. The books are wrapped in tissue paper and tied at three places with cotton strings and the chop (or label) of the reeling concern added. Sixteen books are packed in a wooden box (called a *Kori*) and sent to the commission agents at Yokohama and Kobé for sale.

Practically all reeling factories have now set up appliances for testing evenness, cleanness and neatness, and carry out these tests. This is of great help in pointing out defects to the reelers. (For details of testing *see* Part III).

In some important places re-reeling is carried out in a separate establishment. Several filatures have a re-reeling factory. The small reels are carried from the filatures and re-reeling and testing done here.

18. Export of raw silk.

The commission agents at Kobé and Yokohama deal with the exporters. Dealings are usually in lots of ten bales (a bale=100 *Kin*=133·3 lbs.=1 *picul*), which may be contained in 14 large or 18 small cases and subject to tests being satisfactory. If the tests do not come up to requirements, the lot may be rejected or accepted on a discount but on the condition that it passes the visual test. If it fails to pass the visual test, it may be rejected or accepted on reduced terms.

After this transaction is complete, the silk is packed into exportable bales (133·3 lbs. each) in linen bags (called shirts). These bags are sent to the Conditioning House for conditioning. The Conditioning House after necessary operations attaches a seal which serves as a pass through the Custom House which does not allow any bale to be exported without this pass. The bale is then packed inside thick mats, tied and secured with ropes. It is now ready to be shipped.

Four exporting firms, *viz.*, Hara & Co., Mitsui & Co., Kiito Kaisha and Asahi, have arrangements for getting conditioning done on their own premises. Officers from the Conditioning House come and take away necessary samples and, after carrying out the conditioning test, come and seal the bales.

In the majority of cases, however, the exporters do not possess testing laboratories of their own, although all have arrangements for visual test. In such cases testing is carried out by the Conditioning House free of cost and transactions are carried out on the basis of the certificate issued by it.

19. Raw silk conditioning house.

The Conditioning House carries out the following two functions and serves the very useful purpose of bringing about improvement in the quality of the raw silk, *viz.*, (1) Conditioning of weight and (2) Testing of quality.

Conditioning of weight.—Silk being a hygroscopic substance, it is necessary to determine the amount of moisture in it in order to find out the weight of the actual fibre. The moisture content varies according to the moisture of the atmosphere to which the silk is exposed. Therefore, in order that neither the buyer nor the seller may lose, transactions are effected on "conditioned weight." This means that all moisture is driven out from it by heat to find the absolute weight and 11 per cent. of the absolute weight is allowed for moisture and added to the absolute weight to get the conditioned weight.

The Japanese Government have passed laws enforcing that all raw silk for export and also that used in some of the prefectures in Japan itself where the weaving industry is important shall be conditioned in a Government Conditioning House.

Prefectural Conditioning Houses have been established at Kyoto, Fukui (with five branch houses in the interior of the prefecture) and Ishikawa. No charge is made in these Houses.

For export raw silk there are two Conditioning Houses in Japan, one at Yokohama and the other at Kobé. At present Yokohama deals with about 80 per cent. and Kobé with about 20 per cent. of the export raw silk.

The Yokohama Silk Conditioning House.—The main building, *i.e.*, the Conditioning House proper, has four storeys and there are four large three-storied warehouses attached to it. The buildings are fire and earth-quake proof re-inforced concrete structures occupying eight acres of land and costing about five million yen. The warehouses are leased to a Corporation in which sericulturists and reeling concerns have shares, can accommodate 80,000 cases and charge 2 sen per bale per day for storage.

The Conditioning House has three departments, *viz.*, (1) conditioning, (2) quality and (3) research. The conditioning department carries out conditioning of weight which is required by law and charges one yen per bale. The quality department carries out testing (as detailed in Sections 23 to 25) for private dealers and for the Silk Exchange free of cost. The research department deals with statistics of conditioning of raw silk and chemical and physical properties of raw silk. The conditioning department has equipment and staff for dealing with 4,000 bales of silk every day.

The work of the conditioning department.—The minimum exportable quantity being one lot of ten bales, conditioning is usually carried out in lots. The bales and boxes of silk are received in the ground flour. The receiving station is of a height which makes handling of the bales from and into the trucks and wagons easy. The platform of the weighing balances are sunk to the level of the floor so that the bales need not be lifted but can be weighed on the wheeled carriers which are numbered and are all of the same weight which is checked every day.

On the receipt of a lot, the lot as well as the bales receive numbers and an iron plate, bearing a number and having one face black and the other face red, accompanies the bale in all future operations. The carrier on which the bale is carried about has a receiver into which the plate is fitted.

The ten bales are opened and their skeins are counted. From each of four bales selected at random 8 skeins are drawn out from eight different books, also selected at random. These 32 skeins from each lot are subjected to the conditioning test and are not put back in the lot but are sent to the firm or filature concerned and utilised for domestic purposes.

Each whole bale is weighed. Then the shirt, *i.e.*, the linen bag, is weighed separately. For calculating the weight of the papers covering the books, the strings tying them and the chops, one book is taken from each of five bales selected at random. Each book has three strings of which the middle one is taken. The weight of the five paper covers and five chops and that of the strings multiplied by three

are added together and divided by 5 to get the average tare of one book which, multiplied by 30, gives the tare of the whole bale. After these weighments are taken, all are re-packed into the shirt and the bale is weighed again and deposited at a place with the number plate on it with its red face up to indicate that the operations are complete. The shirt is now closed and a cloth ribbon bearing the mark of the conditioning house and the serial number of conditioning (from the beginning of the year) is fixed and sealed. This ribbon is a pass for the Custom House. A duplicate copy of the pass in paper is placed inside the bale.

The records of the first operation enable calculation of the net weight of the bales, *i.e.*, weight of the skeins minus tares.

Conditioning of the 32 skeins taken at the beginning is done in electrically heated conditioning ovens on the top floor. There are 129 conditioning ovens, fitted with arrangements for controlling the temperature between 130° and 140°C. and with a chain balance which does away with the necessity of handling small fractional weights. Also they need not be deswitched when weights are observed and only a foot pedal need be pressed which shuts off the air current. The eight skeins of each bale are divided into two lots and each lot is placed inside the oven in an open loose hanging condition. The conditioning is completed, *i.e.*, all the moisture is evaporated, in about 30 minutes and constant weight is observed for five minutes. This is called the absolute weight. Conditioning is done to get this absolute weight. Four ovens are looked after by one person, a man.

The fourth and the final operation is the calculation of the conditioned weight of the lot. For the sake of facility a long table has been worked out and is in use for different gross weights, net weights, absolute weights, 11 per cent. of absolute weights and conditioned weights in pounds and kilograms. Certificates are made out and typed after these calculations.

The work of the quality department.—The details have been given in Sections 23 to 25 on raw silk properties and their testing.

The girls and boys working in the conditioning and quality departments are provided with two white uniforms which are alternately washed every fortnight. Their wages are 70 to 80 sen a day and are paid at the end of the month. The girls come after passing their primary school course when about 14 or 15 years old and leave at the age of about 18 or 19 years. They work for 8 hours.

The prefectural Conditioning House at Kyoto has 24 conditioning ovens made by Matsui Shokai, Yokohama, and can condition about 150 *kori* (one case containing 9 *kan* silk) a day. Here the unit is the *kori*. Four hanks are taken for conditioning and divided into two lots of 2 each.

The staff consists of one Director, one Assistant Director and about 15 hands.

The branch conditioning house at Ono, a County of Fukui Prefecture, has four conditioning ovens. The staff consists of one master and 5 hands. The methods followed are those at Kyoto.

20. The Raw Silk Exchange.

The Raw Silk Exchange supplies a public market for the sale and purchase of raw silk and allows transactions in futures. There are two raw silk exchanges in Japan. The one at Yokohama is the most important and was until lately the only raw silk exchange in the world. A second one has come into existence at Kobé. The other raw silk exchanges are the National Raw Silk Exchange of New York formed in 1929 and the Italian exchange opened at Milan in 1930.

The Yokohama Exchange deals with stocks and securities also. The number of brokers is limited to 70 who must be Japanese. The period of future transactions in raw silk is five months. A reeling concern purchasing cocoons to-day can sell its produce in this market for delivery five months ahead, thus avoiding any loss owing to fluctuations of price during this period. The contract for delivery thus entered into need not be actually fulfilled but may and actually does pass several hands. Contracts for which actual deliveries have been made have never exceeded 5 per cent. The exchange insures a reeler against future loss due to depreciation of price and he can thus carry on his business without anxiety. But, on the other hand, it affords scope for speculation and gambling, with which the American manufacturers actually charged the Yokohama Exchange. Therefore daily fluctuations have at present been limited to 200 yen per bale (picul), and in order to improve the integrity of the Exchange silk brokers were taken into the executive and the cash bond for each broker was raised from 10,000 yen to 40,000 yen.

The grade of raw silk used in the quotations is D of 13—15 white on the certificate issued by the Yokohama Silk Conditioning House (see Section 28). Price differentials on this basis are determined once every year in January for 13—15 denier silk, and once every month for 20—22 denier silk. Raw silk price differentials for 1929 were as follows :—

13—15 denier white—

A grade—basic price +50 yen.
B grade—basic price +30 yen.
C grade—basic price +10 yen.
D basis.
E grade—basic price —20 yen.
F grade—basic price —40 yen.

20—22 denier—

W grade—basic price —150 yen.
Y grade—basic price —150 yen.

The Exchange has a staff and a laboratory for visual inspection. It has a warehouse but does not carry on ware-housing business and permits storage in case of necessity at the rate of 45 sen per lot (*i.e.*, 18 *kori* or 10 bales) per day. In cases of actual deliveries owing to contracts in the exchange no storage charge is made.

The quotations in the Yokohama Silk Exchange rule the prices of cocoons not only in Japan but also in Korea and Formosa.

21. BY-PRODUCTS.

Raw silk being the main product of the sericultural industry, the following are looked upon as by-products, *viz.*, cut cocoons, double cocoons, defective cocoons, reeling waste and pupae (or chrysalides). How these are utilised is described below.

Mawata or floss silk.—Cut cocoons are those from which the moths are allowed to cut out. They are utilised in producing what is called *mawata*, a sort of a loose pad formed from the cocoon layers stretched after being softened with soda. *Mawata* is made into vests or used as linings of *kimonos* for use in winter. It is of two kinds, *viz.*, ordinary *mawata* of square size and *fukuro* or pocket *mawata* of the shape of a bag. Square *mawata* again is made into two sizes, small about 9 *sun* or 11⅓ inches square and large 1 *shaku* or about 14½ inches square.

Cocoons, two litres by measure (about 2 kilograms) are boiled with two *momme* (7 grammes) of washing soda. Then they are washed in plenty of water until the dirt is removed. Washing is done mostly by pressure in order not to entangle the fibres of the cocoons. Then each cocoon is taken up singly and by inserting the fingers through the opening it is reversed and the pupal and larval skins are removed. After this it is stretched with the fingers of both hands into a square or a pocket as desired. All this operation is done under water. Square *mawatas* are got into proper size by fitting them on to four pins at the corners of a square frame or board.

For small square *mawatas* three cocoons are worked into one layer, *i.e.*, three cocoons are taken one upon the other and then stretched together and three such layers or 9 cocoons in all go to make one piece. Large square *mawatas* also are of three layers but each layer is made of four cocoons.

Each piece of pocket *mawata* is made of 9 cocoons. Pocket *mawatas* are rather difficult to make and are made from good cocoons. They fetch a little higher price than square ones.

After formation each piece is squeezed between the hands to expel the water and then stretched and dried.

Cut cocoons are also used in spinning mills to produce spun silk. The price is about 16yen per *kan*.

Dupion silk.—Double cocoons are formed by two worms spinning together. The filaments get so much entangled that such cocoons cannot be reeled in the ordinary manner into good raw silk. It is a characteristic of the superior univoltine races, the poly-voltine races seldom producing double cocoons. The proportion of double cocoons in a normal crop varies from about 2 per cent. to as much as 7 per cent.

Reeling of double cocoons is now being carried out in Japan on a factory scale. A series of reeling basins are connected with water and steam as in a filature but the

machine used is a *zaguri* which the reeler girl turns with her left hand and manipulates the cocoons with the right hand. The cocoons are cooked in the same basin for about ten minutes and rubbed with a small brush which feeds the thread. It is a process of repeated rubbing off of the filaments from the cocoons and passing them on to the thread. The thread produced is necessarily uneven and thick. Only one thread is reeled at a time. Sometimes, however, the *zaguris* are turned by machinery and in such cases two threads are reeled in the same machine. The thread produced is known as *dupion* silk or in Japanese *tamaito* silk.

The returns for 1927 show 13,194 factories with 35,035 basins. This industry is of recent growth and is using, in addition to the cocoons produced in Japan, large quantities imported from China.

In the Nara double cocoon reeling factory at Maebashi in a period of actual work of 11 hours the girls were producing 120 *momme* (1 lb.) thread on hand-turned single-thread machines and 150 *momme* (about 1⅓ lbs.) on machine-turned double-thread machines, the thickness of the thread varying from 35 to 55 denier. They are paid 8 to 9 yen per *kan* (8¼ lbs.) of thread produced, earning about 80 to 85 sen per day. A large part of the thread of this size produced from the better sort of the cocoons is fairly even for purposes of weaving. Twenty-five denier *dupion* was quoted in 1929 at about 880 yen and 55 denier at 650 yen per *picul* (133⅓ lbs.), the quotation for raw silk D grade in the Yokohama Exchange being about 1,500 yen per *picul* at the time.

I was informed here that 200 denier *dupion* silk at 300 yen per *kori* (9 kan) or 4 yen per lb. and 240 denier at 280 yen per *kori* were being largely exported to India. The *dupion* silk is mostly utilised in weaving cloth for home consumption in Japan.

Zaguri-ito, or silk from defective cocoons.—Flimsy, crushed and otherwise defective cocoons which cannot be reeled in the ordinary manner are reeled into a coarse thread on the hand *zaguri* as a cottage industry by women. The thread is usually woven for home consumption.

Spun silk.—External layers of cocoons, broken filaments, unreelable cores (pellettes) and dropped cocoons, *i.e.*, those which cannot be reeled on account of some defects and drop in the reeling basins, go to make what is called reeling waste. Unreelable layers and broken filaments are taken out as long and short wastes which are kept loose and clean and not made into tapes as in Bengal. Reeling waste is also obtained from double and defective cocoons. Such waste and cut cocoons are spun into what is known as spun silk in spinning mills. Large quantities of this waste are exported but large quantities are also used in spinning mills in Japan itself. There are about half a dozen very large spinning mills which own about 320,000 spindles. Like the reeling industry the spun silk industry owes its origin and development to the Government which started the first spinning mill in 1877.

Fuji silk, a fabric known and in extensive demand abroad, is one of those made of spun silk. The value of Fuji silk exported in 1926 was 38,162,039 yen.

Pupa oil.—Chrysalides are eaten by the farmers in some places from reeling pans in the same way as in Burma. It is a common practice to feed dry broken ones to carps and eels, although some say that these fishes develop a disagreeable smell on such diet.

Commercial use of the pupae is for the oil extracted from them which is used in making low grade washing soaps. Fresh pupae and dry ones after being steamed are pressed to extract the oil. This oil is mixed with *Kambara* earth, an acid soil from Niigata prefecture, and filtered in a filter press. The clearing properties of the earth are said to be due to aluminium silicate. Mr. Mochida of Godoyushi Glycerine Co. Ltd., Oji, Tokyo is said to have found out a process of extracting and using the oil in making soaps for degumming silk. The process is kept secret. The oil content of the pupae is said to be about 30 per cent. of the dry matter. Pupae sell at about 1 to 1·25 yen per *kan* in dry condition.

PART III.—TECHNICAL—RAW SILK PROPERTIES AND TESTING OF THEM. CLASSIFICATION OF RAW SILK.

22. PROPERTIES OF RAW SILK.

A description of the properties and the methods and machinery for testing them is given here. For further details the publications listed at the end should be consulted.

The properties of raw silk are described as colour, lustre, hand, nature, nerve, evenness, cleanness and neatness. Nature and nerve are taken to be the result of the combined effects of the qualities as at present understood of strength, elongation, cohesion and elasticity.

Tenacity denotes strength, *i.e.*, power of supporting weight and formerly elasticity denoted elongation before breaking. This conception of elasticity is now changed. Silk stretches to a certain point and returns to its original length. This is real elasticity. If stretched beyond this point, called yield point, it loses elasticity, *i.e.*, becomes permanently elongated and after certain elongation breaks. As regards strength, according to the Raw Silk Classification Committee of the Silk Association of America, a silk is low which measures 3 grammes per denier on the Serigraph and 3·5 grammes per denier on the Serimeter, and threads which break at twenty-five grammes are considered weak threads, regardless of their size. The standard taken in the Yokohama Conditioning House is 3·7 grammes per denier.

Hand (the property of filling when a silken stuff is held between hands) is really due to elasticity. Cohesion means the quality of the component filaments making up a thread to stick together and depends on the quality of the sericin. Evenness in raw silk denotes that its thickness (technically expressed as size) will be uniform throughout. Uniformity of size is expressed as evenness.

The thickness of silk thread or size is indicated by the weight in *deniers* (a denier is equal to five centigrams) of a length of 450 meters. If this length weighs one denier, the size is one denier, if 14 deniers the size is 14 denier.

Cleanness and neatness express freedom from certain defects described below.

It is also required that raw silk hanks should unwind easily with no or few break-

23. DEFECTS OF RAW SILK.

Raw silk, being the product of the filaments of several cocoons joined together and the filaments themselves again being of varying length and varying in thickness in different parts, complete evenness can never be guaranteed. Besides, in reeling raw silk from cocoons various defects occur in it such as knots on breakages, slugs, nibs, wastes, etc., which run up from the reeling basins and stick to the thread, corkscrews and loops due to some of the component filaments of the thread being

too loose, hairiness, lousiness, etc. These defects may be due to bad reeling, bad cocoons or bad treatment of the cocoons.

The quality of a lot of raw silk depends on uniformity in the properties. When the colour is not uniform there is a difference of shading on dyeing with the same dye and in the same vat. If cocoons with different properties as regards elongation are reeled together, the filaments with say 10 per cent. elongation will break, while those with 20 per cent. elongation will stand a certain strain. Evenness in size and cleanness are essential for producing a high class uniform cloth.

Also from its raw state to the finished goods the silk thread has to pass through various processes of throwing and weaving. Its quality is judged by the ease with which it passes through the various machines and by the quality of the finished product. The defects which interfere with both are broadly divisible into :—I. Evenness defects of the thread itself. II. Other defects mostly extraneous of the thread. III. Defects of the skein.

(i) *Evenness defects of the thread.*

Evenness is the first quality looked for and wanted. In practice it has been found that variation in the size of raw silk to the extent of 30 per cent. on either side, *i.e.*, towards thickness or thinness, are levelled up in throwing when two or more threads are doubled into a yarn. This means that in the case of say 14 denier silk portions which are thinner down to 11 denier or thicker up to 17 denier do not interfere with the processes of throwing and weaving and also do not show as defects in the finished product. Greater variations are defects which are described as—

Fine.—When the size is 30 per cent. or more but less than 50 per cent. below the average size of the thread.

Very-fine.—When the size is 50 per cent. or more below the average size.

Coarse.—When the size is 30 per cent. or more but less than 50 per cent. above the average size of the thread.

Very-coarse.—When the size is 50 per cent. or more above the average size of the thread.

The same percentages hold good as regards strength and portions are called fine, very fine, coarse or very coarse when they break at the above percentages of the average strength of the thread.

(ii) *Other defects of the thread.*

A. Major defects (Fig. 32). Waste is a mass of tangled fibres on the thread.

Bad casts are abrupt thicknesses on the thread due principally to adding more than one cocoon filament on the thread at a time at the time of reeling.

Slugs are thicknesses on the thread several times the diameter of the thread and about one-eighth inch or more in length. Long or large slugs are those which are more than half an inch in length and much thicker than small slugs.

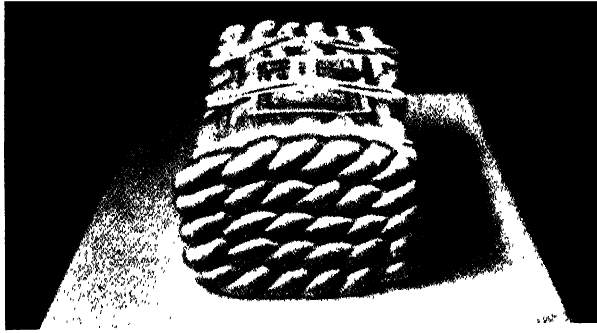


Fig. 29. A finished book.

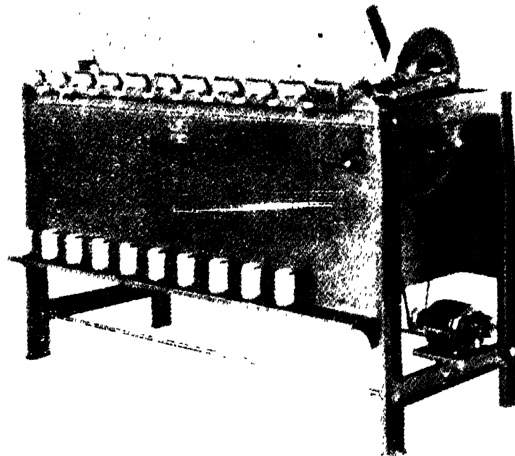


Fig. 30. Seriplane.

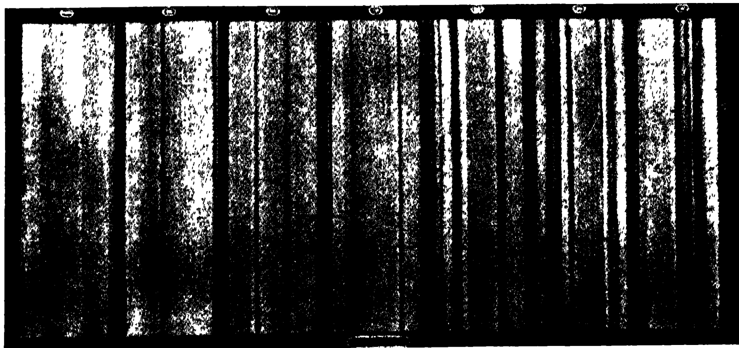
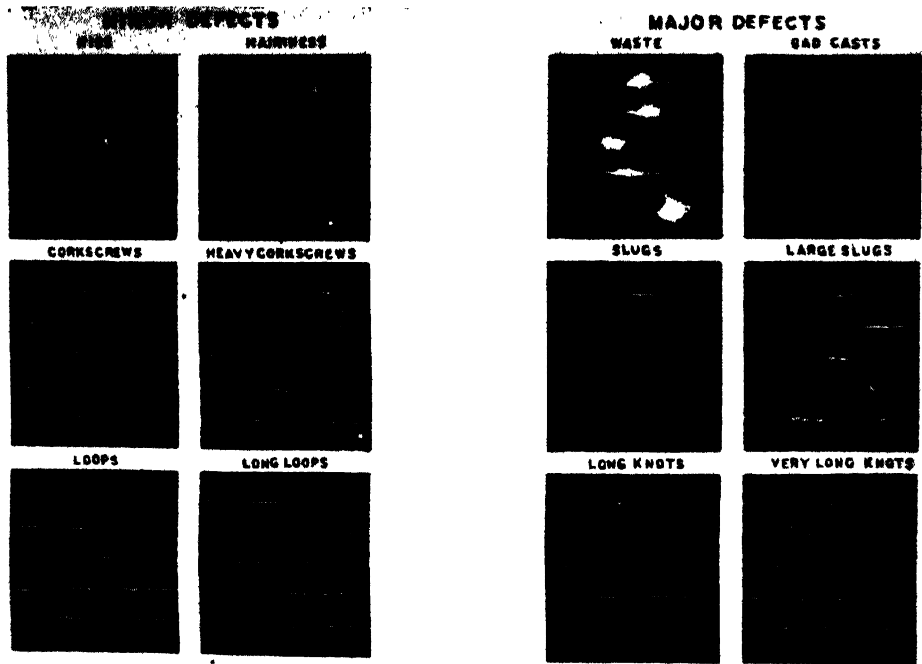


Fig. 31. Evenness standard.



Defect Standard

Fig. 32. Defects standard.

80 60 40

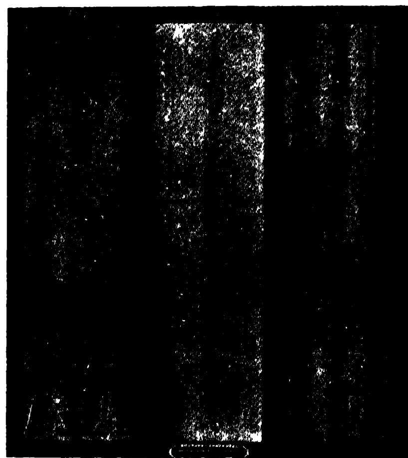


Fig. 33. Neatness standard.

Long knots are knots with the loose ends from one-eighth to one inch long.

Very long knots are knots with the loose ends more than one inch long.

B. Minor defects (Fig. 32). Nibs are small thicknesses on the thread less than one-eighth inch in length.

Hairiness is due to numerous loose ends projecting from the surface of the thread. Loops of a loopy thread when broken produce similar effect.

Corkscrews are places in which one or more cocoon filaments are longer than the remainder and appear to be spirally wound on the thread.

Heavy corkscrews are those which are more than twice the diameter of the thread. Loops are small open places on the thread due to one or more cocoon filaments being longer and loose appearing as loops on the thread. Long loops are those which are more than half-an-inch in length. *Cleanness* expresses degree of freedom from waste, bad casts, small slugs, large or long slugs, long knots, very long knots and heavy corkscrews. *Neatness* expresses degree of freedom from loops, nibs and hairiness. This classification of the major and minor defects is according to the Silk Association of America.

In Japan the following classification is adopted :—*viz.*, *Major defects*—wastes, large slugs, bad casts, very long knots and heavy corkscrews. Wastes and large slugs are often taken to be the same.

Minor defects (called Medium defects in the Yokohama Exchange)—small slugs, long knots, corkscrews, long loops and loose ends.

Neatness defects (called Minor defects in the Yokohama Exchange)—hairiness, nibs, loops, raw knots, fine corkscrews and fuzziness.

Cleanness is taken to express freedom from major and minor defects.

The classification of some of the defects as major and some others as minor does not convey a correct idea of the value of the different defects which assume importance according to the class of goods in which the thread is used. Throwsters look at the defects from various angles. Some defects, *viz.*, wastes, large slugs, large knots, large casts and large corkscrews, can be eliminated with care. There are others, *viz.*, loops, small slugs, long knots, nibs, split and loose threads and fine and double ends, over which the throwster has hardly any control but which cause trouble afterwards and are therefore looked upon as of major importance.

C. Miscellaneous defects. Lousiness is a defect which appears in some silks when dyed, as specks, masses of silk fibrillae which do not show the colour of the dye. Finished goods look speckled.

Raw knots are the necessary knots made in tying breaks during reeling and re-reeling operations. The loose ends of the knots should be less than one-eighth inch long.

Double threads consist of two or more threads running together in the raw silk.

Lapped or loose ends are breaks which are not tied with a knot but simply twisted together.

Split threads are due to brittleness of some of the component filaments of the thread; their elongation being less than about eight per cent. Loops of a loopy thread breaking in the operation of winding, knitting and dyeing behave like split threads. Presence of impurities on the thread such as sand, lime, magnesia, salts and grease.

(iii) *Defects of skein.*

Loose threads in the skein—Small pieces of threads only about a few inches long, usually the cut and rejected ends of the knots given on breakage, get caught in the skein at the time of re-reeling unless carefully thrown out.

Improper diamond and improper crossing in the skein.

Matted skein—when the threads are matted together. With re-reeling practised after reeling this defect has almost ceased to exist.

Hard gums or gum-spots—when the threads of the skein get matted at the points which touch the bars of the re-reeling frame.

24. Tests of raw silk.

Evenness test aims at finding out the evenness of a lot of raw silk.

The methods now practically in universal use are what are known, as *seriplane* methods devised in America.

A seriplane is a frame designed to revolve an inspection board at a uniform rate of speed (Fig. 30) and equipped with direct-driven traverse by means of which the thread can be spaced uniformly on the revolving inspection board and also with devices to adjust spacing according to the size of the thread, to secure uniform tension on the thread and to indicate the number of turns of the thread on the board.

An inspection board is one with flat black surface, one meter in circumference round its width and long enough to accommodate 10 panels of thread, each panel being thirteen centimeters (five inches) wide. Threads are spaced in the panels at the rate of 100 per inch for 13—15 denier and 80 for 21—23 denier silk. In order to facilitate determination of the length of thread in any portion of the panel the boards are marked for each ten meter lengths of thread wound on it.

The panels of thread on the inspection board are compared with Standard Evenness Photographs of Standard panels prepared and approved by the Silk Association of America indicating relative values of evenness expressed in percentages (Fig. 31). The evenness standards at present in use show seven percentages of evenness, *viz.*, 100, 90, 80, 70, 50, 30 and 10. The panels under inspection are compared and rated according to these percentages. Between 100 per cent. and 50 per cent. rating is allowed to the nearest 5 per cent. and below 50 per cent. to nearest 10 per cent.

The inspection is required to be done in a specially arranged room as indicated in Fig. 34. The inspection boards are required to be supported on a standard seriplane rack (Fig. 35) not more than two at one time with the standard photograph

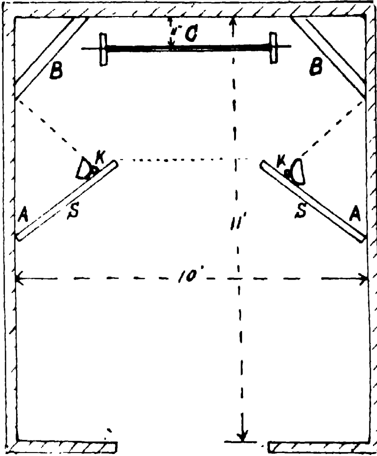


Fig. 34. Seriplane board inspection room. External surfaces of reflecting screens S, walls B, C and floor inside dotted lines are painted flat gray. The rest of the floor and walls, ceiling and internal surfaces of screens are flat white.

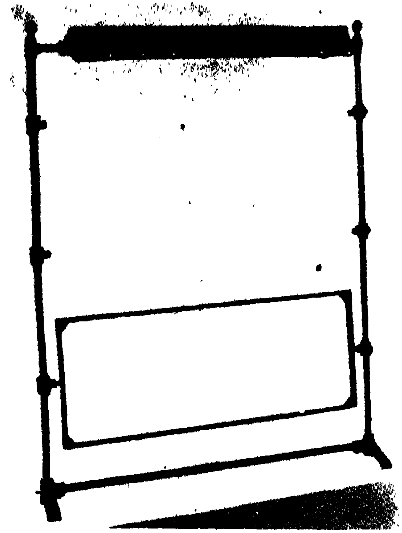


Fig. 35. Rack on which inspection boards are required to be placed. The evenness standard and two inspection boards are accommodated at the same time.

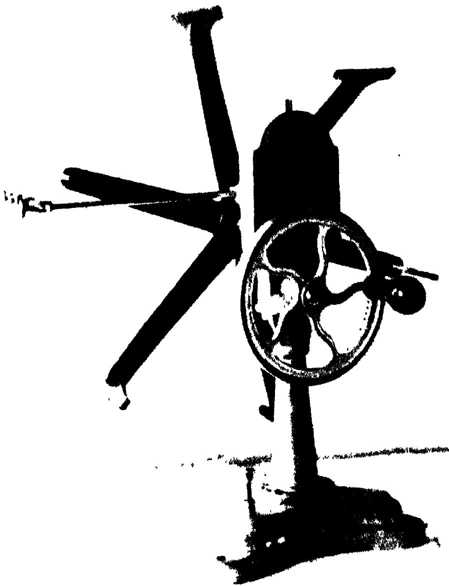


Fig. 36. Sizing meter.

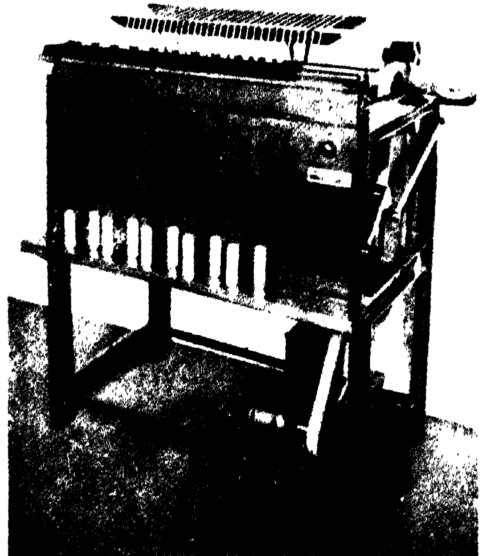


Fig. 37. Sizing reel.

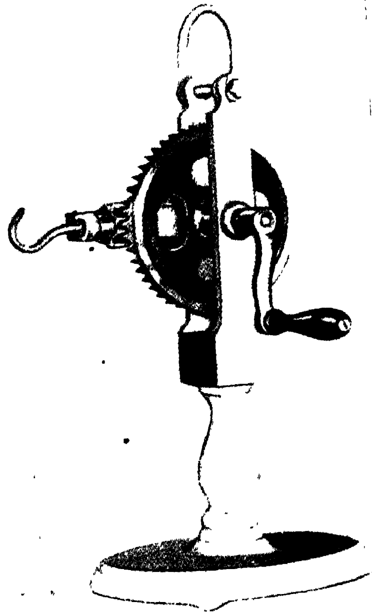


Fig. 38. Sizing skein twister.

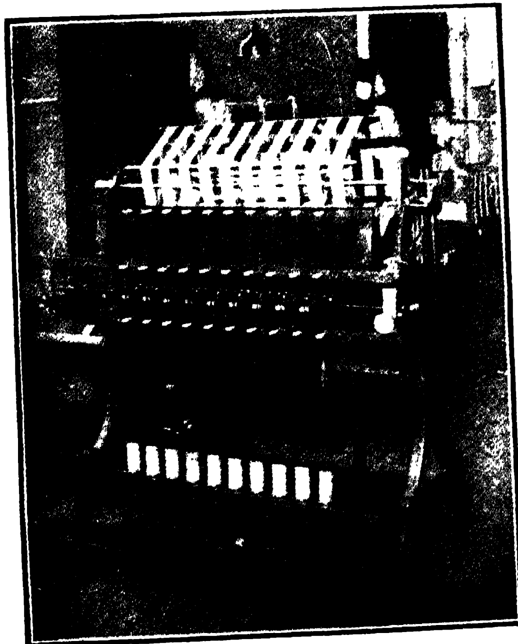


Fig. 39. Seem's gauge machine.

supported on the same rack in the same vertical plane, preferably adjoining it, but never removed from it more than the depth of one board. Two banks of incandescent lamps in reflectors K arranged vertically towards the ends of the rack are arranged to give a uniform illumination of all panels and photographs without allowing direct light to fall on the rack. The inspector takes a position directly in front of the rack at a distance of seven feet. Any portion of the thread is taken to be uneven if its thickness changes in sufficient degree to be noticeable by visual inspection and the degree of unevenness expresses the amount of change in thickness.

Evenness of a lot of raw silk is further tested by average size and size deviation tests.

Average size test is intended to find out the average size of the thread in a lot. This is carried out by taking sample skeins from the lot and then taking from the sample skeins a number of sizing skeins each 450 meters long.

Sizing skeins can be taken with the help of an ordinary sizing machine (Fig. 36). An electrically driven machine (sizing reel) in which ten skeins can be taken at a time is in universal use (Fig. 37). The sizing skeins are weighed on an analytical balance and average denier worked out. Sometimes average denier is worked out on conditioned weight of the sizing skeins. A special twisting machine (Fig. 38) is used for twisting the sizing skeins.

Size deviation test aims at determining the deviation of each sizing skein from the average size and average mean deviation per skein from the average size. The sizing skeins taken for the average size test are used and require to be weighed individually on a quadrant balance. The deviation of each skein is the difference between its size and the average size taken to the nearest half denier. Average (mean) deviation per skein is obtained by taking the total of the number of deviating skeins multiplied by their deviations in half deniers and dividing this total by the number of sizing skeins.

Cleanness test. Both in America and Japan what are accepted as major and minor defects are counted on the panels of the seriplane board but penalties for them are calculated in a slightly different manner. The standard photograph is also referred to for comparison (Fig. 32). For this purpose as well as for neatness test, the lights at the ends are put out and the lights at the top of the inspection rack are switched on and used.

Neatness test. Neatness is estimated by the extent to which loops, nibs and hairiness are present on the inspection panels as compared with standard photograph panels for neatness (Fig. 33) which show three percentages *viz.*, 40, 60 and 80. The estimate is made to the nearest 10 per cent.

Gauge test. For determining thread defects Seem's Gauge machine is sometimes used (Fig. 39). The thread under test is wound on bobbins. Threads from ten bobbins are passed through the Gauge machine. This machine has metal plates in pairs. Each pair has a slot regulated for the size of a thread. The 14 denier slot

will catch a thicker thread and cause it to break. The defects are also caught up and cause breakages. Fine threads pass through but very fine threads break on account of the tension arranged for in the machine. When breakages occur, the ends are examined and the cause recorded. In the case of thick or thin ends, their denier is determined with the help of a torsion balance.

The following certificate of Gauge test explains its work. Testing is done in three ten-minute periods.

Test made on 10 skeins Japan raw.

——	Test on 30 thousand yards.				Total on basis 30,000 yards.
	1st 10 mins.	2nd 10 mins.	3rd 10 mins.		
THREAD DEFECTS—					
Weak threads	..	1	1	..	1
Fine threads	2	5	3	..	10
Very fine threads	2	..	1	..	3
Coarse threads	1	1	1	..	3
Very coarse threads	2	1	2	..	5
TOTAL	7	7	8	..	22
DEFECTS—					
Major—					
Waste	..	1	1	..	2
Slugs	1	..	..	..	1
Large slugs	..	..	1	..	1
Bad casts	..	2	..	..	2
Long knots	1	..	..	..	1
Very long knots	..	..	..	..	..
TOTAL	2	3	2	..	7
Minor—					
Nibs	4	7	4	..	15
Hairiness	1	3	1	..	5
Corkscrews	17	20	17	..	54
Heavy corkscrews	7	9	10	..	26
Loops	20	24	26	..	70
Long loops	2	3	2	..	7
TOTAL	51	66	60	..	177
GRAND TOTAL	60	76	70	.	206

Tenacity and elongation are tested on a machine called a Serigraph (Fig. 40) which has now replaced the serimeter (Fig. 41). Tenacity by the serigraph test is taken to express the breaking force (strength) in terms of grammes per denier. At the same time it records a graph on a chart. This graph is a straight line up to the yield point which marks elasticity and then bends and continues to the point of breakage which marks elongation expressed in percentage. A bunch of threads (usually the sizing skeins) is tested at once in the serigraph, the number being 400 for silk

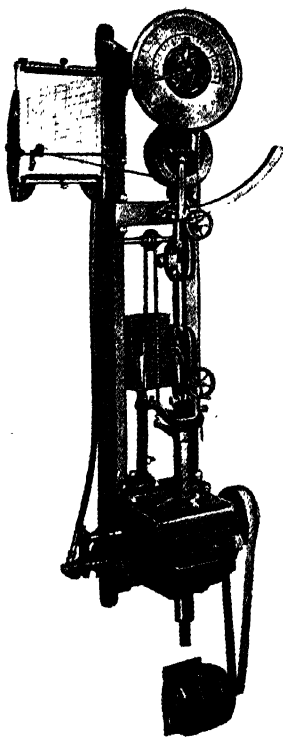


Fig. 40. Serigraph.



Fig. 41. Serimeter.

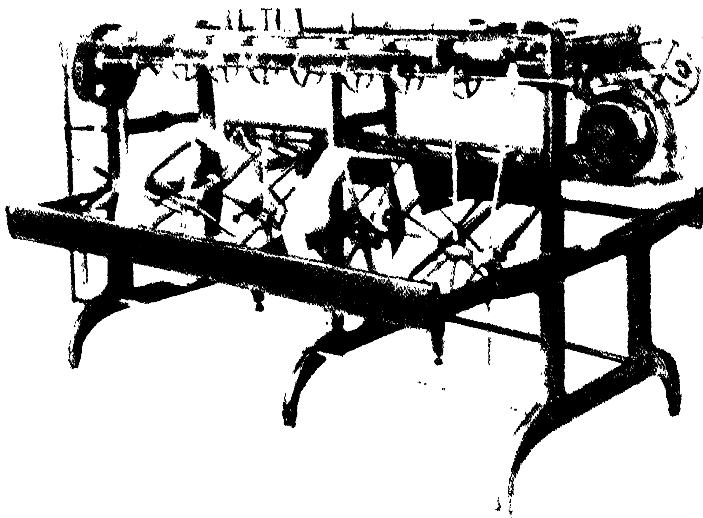


Fig. 42. Winding machine (Aswood).

up to 13 denier, 300 for 13 to 20 denier, 200 for 21 to 28 denier and 100 for 29 denier and above. *Serimeter* indicates breaking 'strength' in grammes and elongation (hitherto called elasticity).

Cohesion test. This is carried out by cohesion testing machines. In Seem's cohesion tester a number of strands of the silk thread are subjected to the action of a roller which moves to and fro. The number of strokes necessary to separate and open out the component filaments of the thread are noted and the greater the number of strokes necessary, the higher the cohesion.

In the Duplan cohesion tester a continuous thread is passed between two sets of porcelain hooks in a zigzag manner under constant and uniform tension in such a way that the thread can be subjected to friction at twenty different places simultaneously. The number of strokes necessary to open the filaments is recorded by an automatic counter.

The Duplan tester is the one preferred by all and is used by the Yokohama Conditioning House.

Winding test is intended for finding out the continuity of the thread and how it will behave in the first process of winding in the throwing operation. This is carried out on winding machines (Fig. 42) and indicated by the number of breakages per hour, per weight or per length.

Boiling-off test. The silk filament is a fibre (fibroin) covered with a gum (sericin). On degumming the gum is dissolved and it is the fibre which goes to make the ultimate thread. Therefore in judging the quality of a silk, the gum is boiled off to see its proportion to the weight of the raw silk. In ordinary transactions the boiling-off test is not usually resorted to.

In the Yokohama Conditioning House ordinary white raw silk is tested as follows:—Take silk 4 grammes, water $4 \times 30 = 120$ c.cs., best Marseilles olive oil soap 18 per cent. of weight of silk, and crystal soda 3 per cent. of weight of silk.

Put in the silk when the temperature of the bath is 98°C. and continue for 1½ hours. Then wash.

For yellow silk no soda is used but soap 30 per cent. Boil in one bath for one hour and in a fresh second bath for one hour and then wash. In the United States Testing Co.'s laboratory 100 to 115 grammes silk are taken and tested and pure neutral olive soap is used. For raw silk the soap used is 25 per cent. of the dry weight of silk and water one hundred times the weight of silk. The silk is put in when the bath is at boiling temperature and boiling continued for 30 minutes. The silk is then rinsed in hot water and gradually passed to cold water. The operation is repeated in a second bath. Drying is done in a gas oven. For thrown yarn the soap used is 45 per cent. of the dry weight of silk and the two boilings are for three-quarters of an hour each, and in the last washing about ½ per cent. glacial acetic acid is added.

Colour and *lustre* are judged by sight and for this purpose an inspection room is fitted for securing uniform light from the northern sky. On the outside of a large

window a tunnel-like wooden structure is fitted and its inside painted black. Inspection is carried out near this window with light coming through the blackened tunnel on a table with black surface. Light from behind the inspector is prevented by means of black curtains hung all round. Uniformity in colour and lustre is aimed at in a lot. Uniformity in the look of books, finishing defects, etc., are also judged at the same time. The inspector also judges that rather indefinite property called *nature** by feeling with his fingers the hardness, softness, smoothness and roughness of the hanks in the book. Judging of nature is up to now a question of experience and is almost wholly dependent on the human factor. An inspector judges the feel and resiliency of a hank with his fingers and sometimes looks at the broken ends of a piece of the thread. If the broken ends are split, the silk is taken to be of low quality and if unsplit of good quality. This is the result partly of cohesion and partly of strength, elongation and elasticity of the component filaments of the thread. If the component filaments vary considerably in the three latter qualities, their lengths at the broken ends will necessarily vary considerably and low cohesion of course leads to their seperation. An experienced silk weaver of Benares, totally unacquainted with the modern development in testing and testing appliances, once described that he judged the quality of China silk simply by examination of broken ends.

25. Testing of raw silk in Japan.

The evenness test with the seriplane is divided into two tests, *viz.*, Test A and Test B.

Test A. In this the size, length and number of the uneven portions on the inspection panels are taken into consideration and penalties calculated according to certain rules.

As regards length the uneven portions are divided into three classes, *viz.*, those less than 50 meters, those more than 50 but less than 100 meters and those 100 meters or longer.

As regards size the uneven portions are divided into fine, very fine, coarse and very coarse according to the method described above under evenness defects.

These variations in size are determined at the Yokohama Conditioning House with the help of a Hand Serimeter invented there and in some other places with a torsion balance.

The Hand Serimeter (Fig. 43) is a metal tube with a spring inside, a pointer to indicate the position on the graduations on the tube and a hook at the end of the needle which is connected with the spring inside. The threads to be tested are first of all held tight on one edge of the board with the help of metal claspers supplied with the hand serimeter. The hand serimeter is held between the fingers. The

*Warren P. Seem has recently described a machine for judging *nature* in the *American Silk Journal*, Nov. 1930.

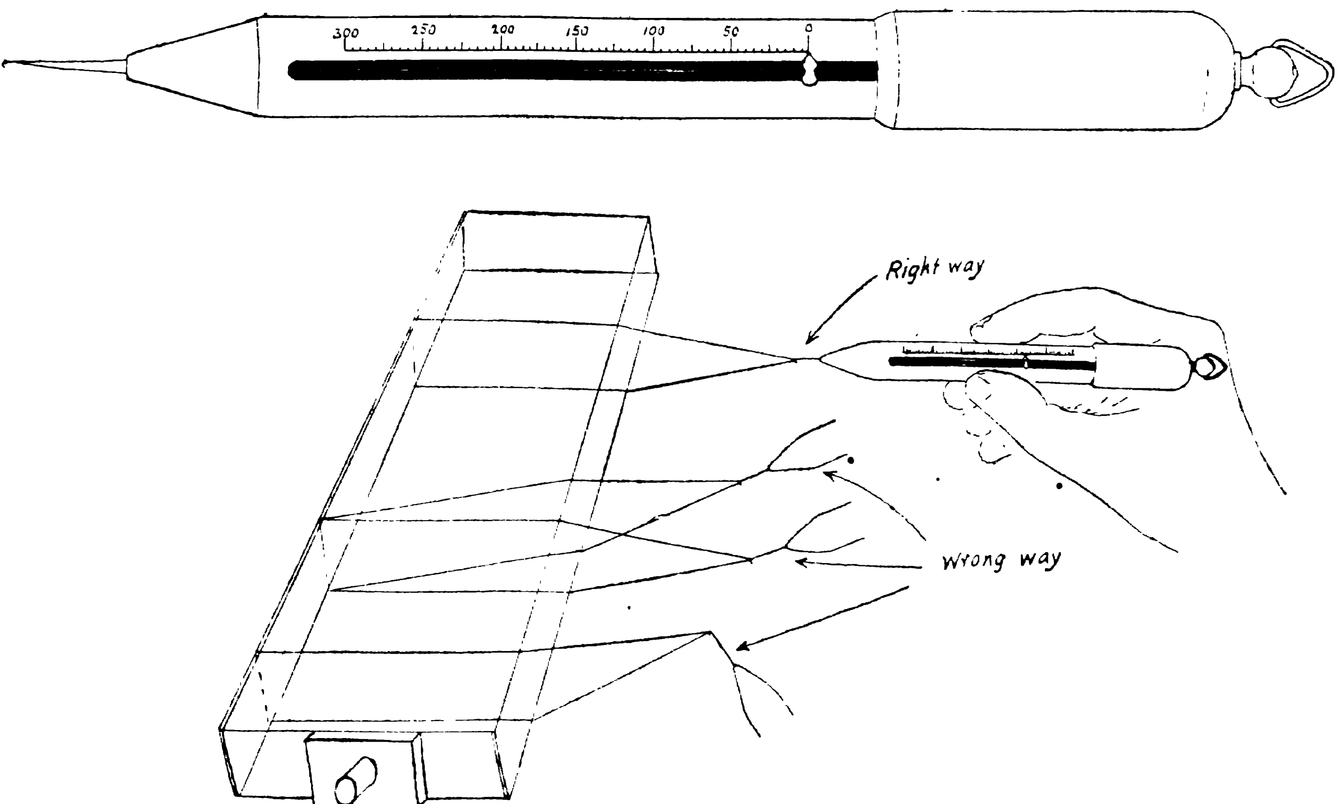


Fig. 43. Hand Serimeter—Correct method of pulling the thread on the inspection board is indicated.

hook is made to catch one thread at the free edge of the board and the thread pulled in a straight line with its position on the panel. The pointer moves with the pull on the spring and remains at its position when the thread breaks, indicating breaking strength of the thread expressed in grammes. Suppose one strand on the inspection panel breaks at 95 grammes. The breaking strength of one denier is 3·7 grammes but as the hand serimeter actually pulls a double strand $95 \div 3{\cdot}7 \times 2 = 12{\cdot}8$ denier is the size of the thread. Whether the thread tested is fine, very fine, coarse or very coarse is easily found out by reference to a calculated table.

The Torsion balance is used to find the size of short lengths of raw silk. The weight of nine meters of raw silk indicated on the graduated scale by the pointer shows the denier of the silk. The threads require to be cut off from the inspection panel and weighed on the torsion balance.

Test B. The percentages of the panels corresponding to the percentage or to the nearest percentage of the standard photographs are noted and the average percentage worked out.

Evenness test is the average of tests A and B.

The following methods of testing are adopted and made compulsory by law in Japan with effect from 1st January 1932 for all raw silks for export.

The tests are classified as—

1. *Quality or mechanical tests* comprising

1. Major tests for (*a*) evenness defects and (*b*) cleanness defects, which are divided into (*i*) major, (*ii*) minor and (*iii*) neatness defects.

2. Auxiliary tests for (*a*) winding, (*b*) size deviation, (*c*) tenacity and elongation, (*d*) cohesion and (*e*) average size.

Quality tests are carried out after completion of visual inspection on a lot, consisting of one to ten bales and the samples consist of fifty skeins drawn out at random from different parts of the bales, not more than one skein being taken from the same book. *Evenness* defects are determined by intensity of variation in the size of the threads in each of 100 seriplane panels prepared at the rate of two from each of the 50 skeins by comparison with (*a*) Standard Variation Photographs indicating intensity of variation and (*b*) Standard Evenness photographs indicating relative values of evenness expressed in percentages.

These photographs are said to be under preparation by the Yokohama Conditioning House and until they are ready those issued by the Silk Association of America Inc. will continue to be in use.

For *cleanness test* Standard photographs for major and minor defects (*i.e.*, cleanness) and those for neatness defects prepared by the Yokohama Conditioning House are required to be used.

Cleanness defects in the 100 panels are counted and penalties awarded at the rate of ·4 per cent. for each major and ·1 per cent. for each minor defect.

Percentage of neatness is ascertained by comparison with the standard photographs.

For *winding test* 20 skeins are wound from outside, 20 from inside and 10 from the middle part for 1 hour 10 minutes. During winding the laboratory is required to be kept under conditions of standard humidity, *i.e.*, humidity in which raw silk contains 9·91 per cent. moisture, equivalent to 11 per cent. regain on absolute dry weight.

For *size deviation* test 4 sizing skeins from each of the 50 sample skeins, *i.e.*, 200 sizing skeins in all are taken. Each sizing skein is separately weighed on quadrant balance graduated in half deniers and also groups of 20 weighed. The sum of individual weighings should not differ from the total weight by more than 1½ deniers.

For *tenacity* and *elongation* Serigraph is used and 10 skeins out of 50 are tested. For *cohesion* test ten samples, one from each of ten skeins are tested on Duplan machine under conditions of standard humidity. The machine is stopped after every ten revolutions. As soon as open places 6 m.m. or more are observed on each of ten sections, *i.e.*, half of the total number of sections, the test is complete for one sample.

Average size is calculated on 200 sizing skeins on conditioned weight.

II. *Visual inspection* aiming at determining

1. Uniformity of a lot as regards :—

A. Defects arising out of re-reeling, *viz.*, (*i*) stickiness of the parts touching the arms of the reel, (*ii*) hard gum on the twisted skein, (*iii*) irregular traverse, (*iv*) double ends and (*v*) out of traverse.

B. Finishing defects, *viz.*, improper lacing, dropping thread, irregular traverse and short double ends.

C. Packing defects, *viz.*, irregular books or skeins ; improper twisting of skeins and making of books ; floating threads ; lacing of cord through skeins ; cut threads ; striped and hairy threads.

D. Damage due to bad Packing, *i.e.*, damage by friction in the box ; soiled threads ; shrunk thread, books out of shape ; hard gums in books.

2. Nature comprising

A. Colour with degree and uniformity of shade. White raw silk shall be indicated as white, greenish, cream, brownish or grayish, yellow raw silk as yellow, reddish or darkish and their degree as light, medium, deep or very deep.

B. Lustre whether full, moderate or light and its degree as bright, medium or dull.

C. Hand—Hardness, softness, smoothness and roughness.

3. General finish whether excellent, good, fair and slightly inferior.

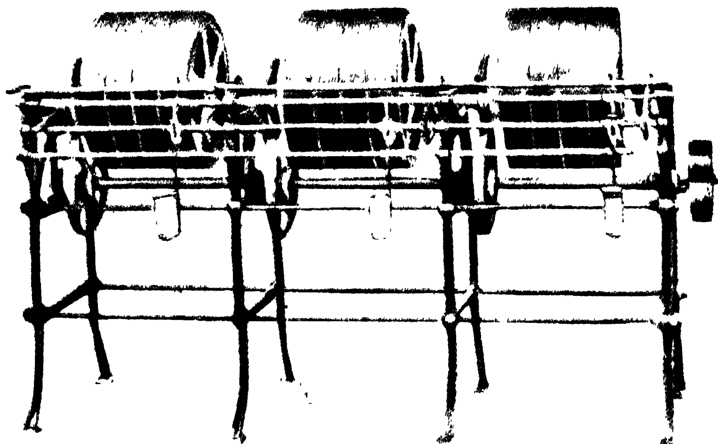


Fig 44. Inspection drums.

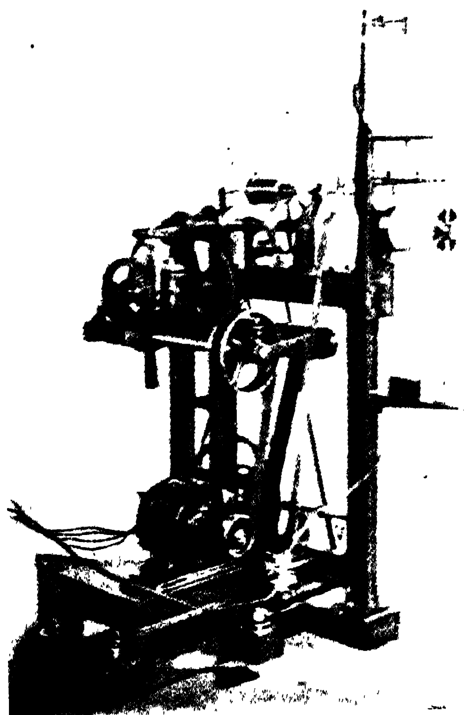


Fig. 45. Tanahashi's Evenness graph.

Testing of small quantities for home use.

In testing a bale (or a case) in the Yokohama and Kobe Conditioning House five sample skeins are taken and subjected to :—

(1) Winding test ;
(2) Sizing test—four sizing skeins being taken from each sample skein and average size determined ;
(3) Evenness test—one panel on seriplane board being taken from each sample skein or a total of five panels ;
(4) Cleanness test—on the five panels ;
(5) Tenacity and elongation—on serimeter, two tests being taken on each of the five skeins.

In the Kyoto Prefectural Conditioning House—for winding test 5 hanks are taken for a *kori* (case) and wound for one hour ten minutes as at Yokohama. There are two winding machines each of 50 bobbin capacity.

For sizing test two sizing skeins are taken from each of the five hanks, *i.e.*, 10 sizing skeins in all. There are two sizing reels each doing 10 skeins at a time.

For strength and elongation the serimeter is used, 10 tests being made for each skein.

For evenness, cleanness and neatness test one seriplane set is used and along with it a torsion balance is in use for finding out fine and coarse threads. There is no hand serimeter.

There are two balances and one machine for recovering the silk from bobbins made for winding test.

In addition to the above outfit there is one small chemical apparatus for testing fat in thrown yarn.

In the village branch conditioning house at Ono, Fukui Prefecture, no seriplane but five inspection drums (Fig. 44) are used. Here there are one 20-bobbin capacity winding machine, one 10-thread sizing machine, one serimeter and two balances. The methods followed are the same as at Kyoto.

Tests as carried out in the Yokohama Silk Exchange.

The mechanical tests are done in the Conditioning House to which the Exchange sends 50 sample skeins.

Visual inspection is done by its own inspectors of whom there are three. The inspector stands near the inspection table on which the books for examination are placed. He takes each book in both hands, observes the hanks forming it and feels them with his fingers. Either some skeins or the whole book may be rejected, The rejected ones are required to be replaced by the suppliers. The accepted lots are sent in boxes to the Conditioning House for conditioning. There the boxes are opened and repacked and a seal put on the tying rope. Thus sealed the boxes come back to the Exchange which puts on another rope and seals it with a metal

seal. If exporters wish to reopen and repack them they apply to the Conditioning House which puts on a fresh seal.

Testing as carried out by exporting firms.

The methods followed by the Japan Cotton Trading Co., Yokohama, are shown below. For their demonstration and explanation I am indebted to Mr. Okajima of the same Company.

When a lot of ten bales (usually in 18 small or 14 large *koris* or cases) is received from the Commission Agents it is opened in the presence of a representative of the latter and 50 skeins drawn out from 50 books selected at random. These skeins are sent to their own testing laboratory for quality tests of the same kind as carried out in the Conditioning House. Their laboratory is very well fitted and they find it convenient and cheaper to maintain a testing laboratory of their own. They supplement the cleanness test by a Gauge test especially for finding out accurately the number of major and minor defects. Counts are taken of 2,000 yards out of 2,020 yards passed through the Gauge. Firms having no laboratory of their own get quality tests done at the Conditioning House but do visual tests themselves.

After the mechanical tests are found satisfactory and acceptable, the whole lot is passed through visual test in the visual inspection room for shape of books, colour, touch, lustre, cohesion, gum, and uniformity. The last three are considered important. The inspector can judge cohesion simply by touch and feel. In case of doubt the Duplan Cohesion Tester is used.

The silk is accepted after it passes the visual tests and then arrangements are made for getting conditioning done before export.

Tests carried out by reeling concerns.

In order to be able to meet the demands in the various tests, practically all reeling concerns have visual inspection rooms and also testing laboratories, although the tests may not be as elaborately carried out as in the Conditioning House.

Breakages are counted as a matter of routine at the time of re-reeling and also a sizing skein 225 meters long taken and tested for size. Skeins of uniform size are placed in the same book. The weight of skeins also is attended to so that there may not be excess or short weight. Colour, lustre, etc., are tested in the visual inspection room and uniformity of the lot is aimed at in every respect.

26. Testing of raw silk in other countries.

In U. S. A.

At present the greatest stress is laid on evenness, cleanness and neatness which are called major tests and which are carried out with the seriplane and standard photographs.

The methods are described with illustrations of machinery in "A Raw Silk Classification with methods of testing" published by the Silk Association of America Inc. 468, Fourth Avenue, New York.

In France.

Full details about testing in the Lyons Conditioning House could not be obtained.

The tests carried out are winding, sizing and serimeter. Five skeins from each bale and four sizing skeins from each skein or a total of 20 sizing skeins used to be taken before and weighed together. From 1st April 1930 six sizing skeins from each skein or 30 sizing skeins were to be taken and weighed separately.

Evenness is determined from the sizing test. Seriplane tests are not officially accepted here yet.

In Italy.

In the Conditioning Houses in Italy also full details about tests could not be obtained.

The tests carried out are :—

Winding.
Sizing—30 sizing skeins being taken.
Serimeter—strength and elongation.
Seriplane—according to American method.

In England.

The London Conditioning House, which has arrangements for conditioning work only, carries out no tests. When tests are required, samples are sent to the Lyons Conditioning House.

27. Attempts at improvement of testing methods and appliances.

Evenness test.

The comparison, judging and rating of inspection panels for evenness in seriplane involves the human factor to a very great extent. Even experienced examiners differ in rating, though within small limits. Therefore efforts are constantly being made to find means of eliminating this human factor. A brief description of these efforts is given here.

In Japan.

(1) Harada's Deniergraph, a machine worked out in the Imperial Sericultural Experimental Station, Nakano, makes a graph of the thread, the graph being

deflected to right or left according to the variations in thickness. The principal part of the machine consists of two metal pulleys of two different diameters. The machine was set up in the Yokohama Conditioning House but is no longer in use.

(2) Prof. Kitao of the Conditioning Department of the Yokohama Silk Conditioning House found that on dipping one edge of the inspection panel in a coloured liquid the liquid was sucked up by the different threads to different heights according to the capillary action varying on the thickness or size. The difference in these heights indicated the difference in thickness of the threads constituting the panel. This method has not been adopted in practice.

(3) Tanahashi's Evenness Graph (Fig. 45), invented by Dr. Tanahashi of the Imperial Institute of Silk Industry, Yokohama, is a recent machine. The thread is wound on a bobbin and is passed to and wound on a second bobbin. After a length of ten meters has passed a magnet comes into play causing two grips to close on the thread and hold it tight. The portion thus held tight is 100 mm. in length. Immediately afterwards the magnet recedes causing this portion to stretch and the stretch is recorded by a red line on a sheet of white paper which gradually unrolls. The stretch permitted is 6 per cent., *i.e.*, 6 mm., and it varies according to the thickness of the thread. The record of a thread with a higher denier is longer than that of one with a lower denier. Therefore the series of red lines which get arranged side by side indicate by their length the variations in denier. After one thousand meters has passed, the machine automatically stops. The difference in denier is easily observed and the denier of each 10-meter portion of the thread recorded can be determined with the help of a calculated scale supplied with the machine. By using bobbins of different diameter tests can be taken of every 5, 7½ or 10 meters as desired. By experiments 10-meter tests have been found quite satisfactory. One thousand meter length is equal to 2 seriplane panels. It is claimed for this machine that it completes the test in 10 minutes, while the seriplane takes 15 minutes simply to do the winding on the board. There are many breakages in the seriplane while there is none in this machine. The machine gives a very correct record and is worked by a ⅛ H. P. motor. Five thread machines, *i.e.*, those in which 5 threads can be tested at a time with a ¼ H. P. motor are being made for the Yokohama Silk Conditioning House.

A single thread machine complete with motor is priced at 1,100 yen and a five-thread one at 2,500 yen.

In America.

(4) Serrell devised an apparatus as early as 1881 with a pendulum movement provided with a point for making a trace on smoked glass or some equivalent. It did not come into use.

(5) A recent device (made known in October 1929) by Mr. H. S. Wyckoff, Engineer of the United States Testing Co. (Figs. 46 and 47) makes use of two wheels with smooth flat broad peripheries. While the wheels revolve, their surfaces touch

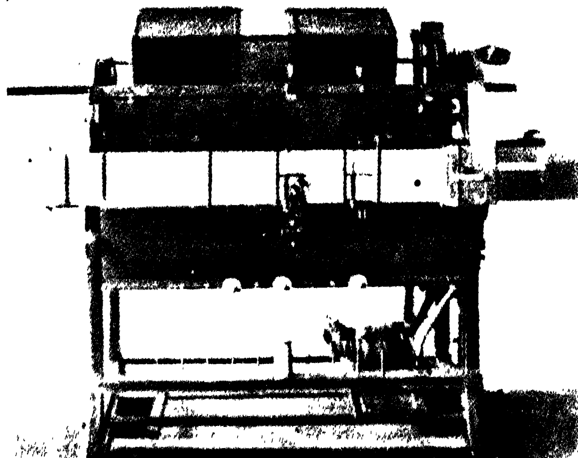


Fig. 46. Wyckoff's Evenness Tester.

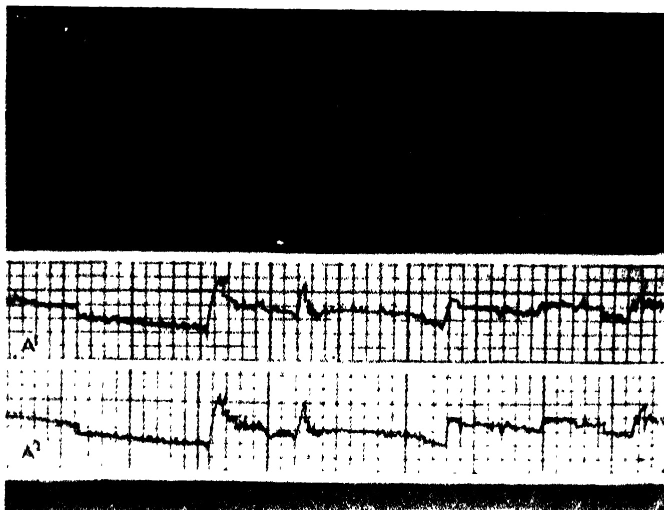


Fig. 47. Record of Wyckoff's Evenness tester. The graph below (repeated) and the photo of the panel on the four face drum.

each other. The smaller wheel is turned by the thread passing over it and turns the larger one. The larger one has its axis off-centre so that it permits threads of different sizes to pass between it and the smaller wheel, its eccentricity equalling the thickness of the thread. The back and forth movement of the larger wheel depending on the variation of the thickness of the thread causes a pen to trace a graph on a paper moving at a uniform rate. The graph is higher or lower as the distance between the wheels is greater or smaller. This device is attached to a four-face drum (each face measuring ¼th meter) on which the thread is wound beyond the wheels and which serves the purpose of the seriplane board.

For measuring evenness Dr. Tenahashi's Evenness Graph is scientific and accurate. But the seriplane, although not accurate to the same extent and not supplying any means of determining the size of the thinner and thicker portions, gives a visual concrete idea at once of the evenness or unevenness of a thread. Besides there is no device so quick and evident as the seriplane for judging cleanness and neatness. Wyckoff's device reduces the unevenness to a graph which however cannot be referred to any standard mathematically. The seriplane still holds the field and will probably continue to do so.

Sizing test.

In thin goods, especially chiffon and sheer hosiery, even small defects are not hidden. Therefore proposals have been made for 18 meter sizing tests.

Nature.

Uniformity of nature is also insisted upon for thin products and it is recommended that silks of hard, medium or soft nature should not be mixed. Seem's machine for testing nature has been mentioned above in Section 24.

28. Classification of raw silk.

The grading or classification of raw silk is based on the results of tests for evenness, cleanness, neatness, average size, size deviation, strength, elongation and winding.

No uniform system of grading has, however, yet been decided upon. This is a real necessity, especially in the raw silk Exchanges which permit dealings in futures. The Exchanges in Japan are following one system and that in America is following a different system. Efforts are being made to have a uniform system. The American-Japanese Technical Conference on raw silk classification (April-May 1928) held at Yokohama discussed this question in detail but failed to arrive at an agreement. A second similar conference, styled as International, was held in October 1929 in New York and was attended also by delegates from Italy, France and England. No final agreement was arrived at.

Classification in Japan.

The classification based on the new methods of testing adopted in 1932 is evident from the following statement :—

Grade.	AAA.	AA.	A.	B.	C.	D.	E.	F.	G.
Composite Percentage . .	88·0	85·5	83·5	81·5	80·0	77·0	72·0	67·0	Below 67·0
Major Tests—									
Evenness Average (100 panels)	89	86	84	82	80	77	72	67	67
Average Low Panels (25 out of the 100).	80	77	74	72	69	65	60	54	54
Neatness Defect . .	89	86	85	83	80	77	72	67	67
Major and Minor Defects .	85	85	80	75	70	65	60	60	60
Auxiliary Tests— Size Deviation—									
Below 16 denier . .	1·20	1·20	1·25	1·30	1·40	1·50	1·60	1·60	Above 1·60
Above 16 denier . .	1·40	1·50	1·60	1·70	1·80	1·90	2·10	2·30	2·30

Sub-grade.	a.	b.	c.	d.	e.
Winding-Breaks per hour, in 50 sample skeins—					
Below 17 denier . .	50	60	70	80	Above 80
Above 18 denier . . .	40	50	60	70	70
Tenacity	3·20	3·00	3·00	3·00	Below 3·00
Elongation Per cent . .	18·0	17·0	17·0	16·0	16·0
Cohesion—					
Below 15 denier . .	25	20	15	15	Below 15
Above 16 denier . .	35	30	25	25	25

A lot showing a composite percentage of 90 per cent., or above and exceeding the minimum values specified for AAA grade, shall be indicated as "SPECIAL AAA," to denote the super-excellent quality of the lot.

The grades are determined by the composite percentage which is the sum of the results of the major tests multiplied by the percentage values fixed for the different tests, *viz.*, evenness average 40 per cent., low evenness average 30 per cent., neatness 20 per cent., cleanness (major and minor defects) 10 per cent. together with the minimum values of major tests indicated in the above statement.

Although a lot may conform to all the characteristics of any given grade in the major tests it shall be classified one grade lower if the result of the Size Deviation Test is one or two grades below the minimum value specified for a given grade under the major tests. In case the Size Deviation Test is three grades below the minimum value of the major tests the lot shall be lowered two grades and so on in the same proportion.

The auxiliary tests, Winding, Tenacity, Elongation and Cohesion, are subdivided into five sub-grades a, b, c, d and e. In case the result of any of these tests

falls one sub-grade lower than the minimum value specified for a given grade, the lot shall be rated one grade lower ; if two sub-grades below, the lot shall be rated two grades lower, and so on.

In case the visual inspection shows a slight inferiority in the uniformity and general finish of a lot, such lot may be rated one grade lower.

Classification in United States of America.

The latest official classification adopted by the Raw Silk Association of America and the New York National Raw Silk Exchange is quoted below for comparison with the Japanese from " A Raw Silk Classification with methods of testing ".

Japanese Raw Silk, White and Yellow; Any size.

10 Bale Lots.

Grades.	AAA.	AA.	A.	B.	C.	D.	E.	F.	G.
Major Tests—									Below
Evenness, Average 160 panels %	90*	87	85	83	81	78	73	68	68
Evenness, Average 40 low panels. %	81	78	75	73	71	66	60	55	55
Cleanness . . . . . %	92	90	90		85	80	80	75	75
Neatness . . . . . %	90	85	85		85	80	75	75	75
Auxiliary Tests—									
Size deviation— Average 9 to 15 denier less than.		1·00	1·00	1·10	1·20	1·30	1·40	1·50	Above 1·50
Average 16 to 31 denier .		1·50	1·50	1·50	2·00	2·00	2·00	2·00	2·00
Average size variation— Average 9 to 12 denier . .	·40 denier		·40 denier		·40 denier		..		Above ..
Average 13 to 18 ,, . .	·40 ,,		·50 ,,		·50 ,,		·50 denier		·50 denier
Average 19 to 22 ,, . .	·50 ,,		·50 ,,		·50 ,,		·75 ,,		·75 ,,
Average 23 to 31 ,, . .	·80 ,,		·80 ,,		·90 ,,		1·00 ,,		1·00 ,,
Strength (Serigraph) Grams per denier.	3·5		3·50		3·3		3·0		Below 3·00
Elongation (Serigraph) per cent. .	20·0		20·0		19·0		18·0		18·0
Winding—Breaks per hour per 20 skeins.	10		10		20		30		Above 30

A lot conforming to all the characteristics of any given grade in the *major tests* may test one grade lower in the *auxiliary tests* without degrading the lot, but if the *auxiliary tests* of the lot are two grades lower, the lot is rated one grade below that indicated by the *major tests*.

* The grade AAA is assumed to contain raw silk with Evenness Average from 90 to 93 percent, and Penalty Average from 81 to 83 per cent. Raw silk showing higher values on test will be considered outside the classification and subject to special agreement.

The cleanness defects are counted, both sides, in groups of 40 panels. The percentage is calculated on each group, and the groups averaged for the lot. In calculating the cleanness percentage deductions from 100 per cent. should be made as follows :—

Deduct ·5 per cent. for each waste, bad cast, long or large slug, long knot and very long knot.

Deduct ·1 per cent. for each small slug and heavy corkscrew.

A size range is also fixed :—

—	Grades.				
	AAA. AA.	A. B.	C. D.	E. F.	G.
Size Range (per bale)—					Above
Average 0 to 12 denier	4 denier	5 denier	5 denier	. .	. .
Average 13 to 18 ,, ...	5 ,,	6 ,,	6 ,,	7 denier	7 denier
Average 19 to 22 ,, ...	7 ,,	8 ,,	8 ,,	9 ,,	9 ,,
Average 23 to 31 ,, ...	8 ,,	9 ,,	9 ,,	10 ,,	10 ,,

A somewhat modified new classification has been suggested by the Joint Classification Committee of the Silk Association of America in 1931 for trial before the sitting of the Third International Conference. (See *American Silk Journal*, Aug. 1931.)

The new methods of classification adopted in Japan almost approximate those proposed in the United States of America. They have paved the way for a uniform international system of classification.

PART IV. TECHNICAL—MISCELLANEOUS.

29. PRODUCTION OF SEED.

Pebrine is the worst of all the diseases from which silkworms suffer. It is hereditary and can be eliminated only by examination with a microscope under a magnification of about 600 diameters of the mother moths especially and also of eggs, worms and pupae. As such elimination is not possible by rearers, production of eggs is wholly under the control of the Government. The first generation cross eggs or seed (common seed) required to be reared are obtained the previous year. The eggs of the parent worms (usually spoken of as 'original' seed in Japan) which are crossed to produce the common seed are similarly obtained a year previous to crossing. For instance, rearing of cocoons for reeling into silk is done say in 1930. Common seed (F_1 cross) for this rearing is prepared in 1929. Parent or original seed for preparing this F_1 cross is obtained in 1928. The process involves two rearings, one for parent seed and the other for common seed. Elaborate regulations have been made so that pebrine germs may be eliminated in the preparation of both these kinds of seed. The regulations in this respect are more strict in the case of the parent seed than in that of the common seed, and are given in Section 49.

The practically universal way of preparing common eggs for distribution to the rearers is to get 28 moths to lay eggs on a thick sheet of paper or card (Fig. 4). Its size and the necessary information on it as to the manufacturer, race of worms, date of preparation and the stamp of the controlling station, are all prescribed by regulations. It is marked into 28 squares which are numbered from 1 to 28 for the layings. Such cards are specially manufactured and cost 2 sen each. The moths are isolated on the squares by means of a tin frame (Fig. 48) having 28 cylinders and the frame is covered with a sheet of rubbered cloth having a hole for each cylinder. The price of a completed egg card, *i.e.*, with eggs on it after hibernation and necessary treatment varies from Yen 1·50 to Yen 2·50.

Another method (*hiratsuke*) is to get a number of moths to lay eggs promiscuously on a plain sheet of paper in a wooden tray covered with a card board. The sheet is of course required by regulations to be passed and stamped by an examining station. The Regulations prescribe 100 moths but 45 moths were found to be used and such a sheet of 45 layings was sold at Yen 1·60. This method, where practised, is only for autumn rearing.

A third method (*baradane*) is to get a number of moths to lay eggs promiscuously on a sheet of paper in large wooden trays. This also requires to be passed. The eggs are afterwards washed off and sold in the loose condition in perforated paper or linen bags containing 8, 5 or 2½ *momme* (about 464, 290 and 145 grains respec-

tively) at the rate of about Yen 1·80 for 2½ *momme*, the produce of about 200 moths. This system is practised on a small scale. The Regulations prescribe 100 moths for each sheet but 200 were observed to be used.

After they have finished laying eggs the moths are put in a specially prepared paper box having 14 cells on each side. The two sides of this box are so prepared and hinged that when opened the mouths of the cells allow of the moths being put in or taken out and when closed the moths are isolated in the cells which are numbered from 1 to 28 to receive the moths from the corresponding squares on the egg card. These boxes are tied together into bundles which are easily transported to the controlling stations. Before being sent the moths are dried in drying chambers usually with fire.

In the other two systems each group of moths, 100, 45 or 200 as the case may be, is packed separately and sent up for examination.

Practices in the examining stations vary a little. For common seed 10 per cent. of the moths are examined. This examination is free. If, however, the percentage of pebrine is more than ·9 per cent., all the moths require to be examined and then a charge of 2½ sen per card is made. In others all the moths are examined and no charge is made. In the 28-frame system the eggs of diseased moths only are rejected. In the other two systems which are cheaper, more than ·9 per cent. pebrine entails rejection of all the eggs as they are laid promiscuously by all the moths together. In order to avoid this risk 240 seed cocoons of lots intended for these methods are incubated at about 85°F. to 90°F. and about 90 per cent. humidity and forced to hatch prematurely for examination. Only on successful results of this test are these two methods of egg preparation undertaken. The egg producer prepares eggs in different methods according to the orders placed with him. In 1927 eggs produced in the cellular method formed about 79 per cent., in 45-moth (*hiratsuke*) system about 15 per cent. and in loose (*baradane*) system about 6 per cent.

Large filatures which arrange for egg-production for their own clients sometimes follow different systems. In the egg-producing station of the Gunze Filature at Ayabe 500 moths are made to lay eggs promiscuously on a sheet of cloth about 4′ by 3′ in size. In the experimental stations the cellular method is followed and in most places each female moth is isolated in a cylindrical cell of transparent tissue paper. One end of this cell is closed with a cardboard disc on which the moth lays the eggs.

30. Operations of an egg-producer.

He rears the parent seed supplied from the experimental stations and uses the moths from the seed cocoons thus obtained for producing the first generation cross or common seed for the ordinary rearers. As the experimental stations cannot produce the full quantity of the parent seed required, the egg-producers are allowed to rear parent seed under strict supervision of the controlling station staff. More than ·5 per cent. pebrine entails rejection of the lot for use as parent stock. Where

egg-producers have to rear parent seed they may get sub-rearers under them to rear the worms for production of the common seed.

Egg-producers make use of several kinds of machines for separating male and female seed cocoons by means of their weight. The seed cocoons of which the sex cannot be determined in this method are cut open and the sex of the pupa can easily be determined by certain markings. This method of separating the two sexes by machines is now going out of use and is not practised in experimental stations as the larvae can easily be separated into male and female by certain markings on their body. The male and female seed cocoons and pupæ are kept in separate rooms. The exposed pupæ are buried in a layer of paddy husk over which straw nets are placed. Sometimes newspaper sheets with holes bored in them are used to cover the trays of seed cocoons in order to prevent the pierced cocoons from being soiled by the excreta of the moths. Various devices are used to prevent mistakes and confusion. For instance, a tray with male moths bears a green flag, one with females a white flag. Similarly moths of different breeds are sprinkled with differently coloured powder, for instance, green for Chinese, red for Japanese and so on.

Male moths are used twice. First copulation is allowed for 3 to 4 hours. Then they are separated and kept in the cold store and brought out after one to two days to fertilize a second batch of females and for this second time copulation is allowed for about five hours. This method leads to some economy as about half the quantity of male cocoons can be sold for reeling.

After mating the female moths are placed on sheets of paper which are shaken vigorously thus inducing them to void the excreta. Then they are placed out for laying eggs on the cards and removed and packed the second day in boxes to be despatched to the controlling stations. If any fails to lay eggs or lays unsatisfactory eggs it is replaced by a fresh female. The egg-sheets produced for the spring crop are kept hanging in an airy room at ordinary temperature. They are washed in water about November and placed in cold store. For the summer and autumn crop, which is mostly bivoltine, the eggs are artificially treated in hydrochloric acid at once or after a certain period in the cold store. Acid treatment is carried out either by the egg-producers themselves or in the controlling stations.

By the nature of their work egg-producers are required to have several large rooms or rearing houses. They use trays of large size, about 6′ by 3′. Most of them cultivate their own mulberry while some purchase leaves. They are licensed and do not get the license unless they have five years experience of rearing. At Matsumoto I came across one egg-producer who had fitted up an *adosol* drying plant in his three rearing rooms and used it when humidity went up high. Some have their own cold store; others make use of other's cold stores and pay 2 to 3 sen per egg card, the period of storing extending from about November, December or January to August.

Egg-production is also undertaken by co-operative organisations.

31. Methods of examination for the control of diseases.

Pebrine.

I combine the methods followed in Japan, France and Italy and give only those which I consider simple and sufficient.

Egg. Dr. Paillot's method is the simplest. Take 5 eggs on a slide and add a drop of distilled or ordinary water. Place another slide on top and crush the eggs by pressing the slides. The contents of the eggs get diluted in the drop of the water and flow out. Take these drops and examine. If this liquid is centrifuged examination is perfect. Dr. Paillot has got a small centrifuge specially made by Paul Cooprie, 7 Quai Claude Bernard, Lyon, which he carries about in his motor car and works with the help of the battery of the car.

Empty eggshells are crushed in a mortar with ordinary or distilled water. The liquid is strained through cotton and centrifuged and examined.

Larva or worm and pupa. Pebrinised worms develop dark spots on the body which are a sufficient indication. Any part of the body, especially a bit of the silk gland, is crushed or rubbed on a slide and examined.

Moth. Pasteur's method of crushing the body is followed everywhere with or without a centrifuge, but best with a centrifuge. Here it may be said that the method advocated by Hutchinson in India of examining only the gut is discredited by Dr. Oshima, of the Imperial Japanese Sericultural Experiment Station, and Dr. André Paillot, of the Entomological Station, Saint-Genis-Laval (Rhone), France, at present probably one of the best authorities on silkworm diseases. In their opinion the gut may fail to give indication of the presence of pebrine corpuscles in the body.

Microscope. The Microscope used is generally Leitz with a magnification of 600 diameters. (Eye-piece 4 and objective 7 or 8).

Crushing and examination.—In experimental stations for production of parent seed crushing of moths is generally done with the hands with porcelain mortars and pestles. Actual examination under the microscope varies from place to place to a certain extent. In Nagano Experimental Station for original or parent seed, of which 230,000 layings are prepared here every year, ten girls were seen crushing moths, each working four mortars. Two drops from each of these four mortars were examined by two girls separately. A little fluid from each of the four mortars was then taken and mixed together and examined by a checker. Suspicion of pebrine entailed re-examination of the four.

In the Ueda experimental station, 14 moths were got to lay eggs on one sheet and 9,000 such sheets were prepared every year. A girl crushed the moths and passed the mortar slab to an examiner who prepared slides and did the examination. Then a little fluid was taken from all the fourteen mortars with a copper spoon and mixed together. Three separate drops were taken from this mixture and examined by a

checker. Suspicion of pebrine entailed re-examination of all the fourteen. Each examiner examined 500 layings a day from 8 A.M. to 4 P.M. with half an hour's interval.

In the controlling stations (*Torshi-mari Jo*) for examination of common seed, crushing is usually done in crushing machines made of brass, run by electricity and provided with arrangements for flushing with water for cleaning purposes. The large type machine does 28 moths at a time. It is in the form of a circle on which carriers can be run. One carrier contains 28 cups in which the 28 moths of a card are put. When it is brought into position 28 rods are lowered into the cups and revolved, thus crushing the moths. The rods are then raised, the carrier of cups driven forward, a carrier containing glass slides is brought into position and the rods are lowered so that their tips leave a drop of the body fluid of the moths on the slides. The rods are raised again and the carrier of the slides is driven forward. The slides are then removed after each drop has been covered with a cover slip and passed on to an examiner. The rods are washed and get ready to receive another carrier of cups which are in the meantime washed and provided with moths. After examination, the slides and cover-slips are washed and wiped dry with a cloth for use again. In some places there are hot chambers for drying the slides and cover slips. A small type of moth-crushing machine does 14 moths at a time. The Ueda branch examining station of the Nagano controlling station, which examines moths from 540 seed rearers, does 2,140,000 cards of 28 moths each in a year, working from the end of June to the end of October. It makes use of two large and one small moth-crushing machines. Each large machine, engaging 28 girls, supplies 30 examiners, who turn out 1,050 cards a day, each girl doing 35 egg cards or about 980 moths. A small machine, requiring 10 girls to work, supplies 14 examiners who turn out 500 cards a day.

This branch station with 4 sub-branches is in charge of one Expert with 11 Assistant Experts and engages 80 microscopist girls who are paid at the rate of 65 to 120 sen a day each during the working season. In the off season the microscopists are not paid anything and do nothing. Fresh microscopists are trained at this time for a period of three months. They are neither charged nor paid anything for this training. Many come forward to be trained. This branch trained 30 this year. All stations train microscopists in this manner.

Chemicals used in crushing. In the Imperial Sericultural Station, Dr. Oshima was using ·085 per cent. saline solution which was also used in preserving pebrine corpuscles. The corpuscles were said to live in this solution for a year.

The Mæbashi Controlling Station was using 1 per cent. potassium hydroxide (KOH). In the seed-rearing station of Gunze Filature 2 per cent. KOH was used. In most places ordinary water was used in crushing.

Centrifuge. A centrifuge is used to separate smaller spores and bacteria and precipitate the grown pebrine spores. Dr. Oshima, of the Imperial Sericultural Experimental Station, was using an "Ecco Superior" (E. Collatz & Co., Berlin.)

at 3,000 revolutions per minute for four minutes. Longer periods caused bacteria and smaller spores to settle. In order to secure only the grown up spores he was centrifuging 20 times in succession, using only saline solution for all operations of crushing and washing.

In many of the seed-examining stations for common seed a cheaper form of centrifuge, made in Japan and accommodating 20 tubes at a time, was used. (Suppliers are Kwashiya Matsumoto Kikaiten, 3-chome, Hommachi, Nihombashi-ku, Tokyo). In the Kumagaya controlling station they were using it at 2,000 revolutions per minute for two minutes, and in the Mæbashi controlling station at 1,300 revolutions per minute for five minutes. Many controlling and experimental stations were not making use of the centrifuge.

In the seed-rearing station of the Gunze Filature at Ayabe, the following method was followed instead of using a centrifuge. Moths were crushed in 2 per cent. potassium hydroxide (*Kase Kari* in Japanese) solution, a quantity of ordinary water was added, the whole solution was put in a corked glass tube, the tube left inverted for about 24 hours (about three days are said to give better results) and then the cork was rubbed on the slide and examined.

Flacheric.

According to Dr. Paillot, examination of moths cannot give indication of flacherie and worms must be observed and examination must be carried out in the following manner :—Take a piece of the hind intestine and rub it on a slide, wash with pure methyl alcohol and stain for half to three-quarters of an hour with a solution of Giemsa R at one drop for each cubic centimeter of distilled water. This will give an indication of unhealthiness of cells. Healthy cells will show uniform granulation and in unhealthy ones granulation may be absent in parts or in the whole. This unhealthiness may be due to Gattine or Flacherie. To be sure of Flacherie look for *Bacillus bombycis* (rods) or *Streptococcus bombycis* (chains of spores). The slides are prepared in the above manner or stained with Gentian violet according to Gram's method.

32. Hibernation of eggs.

In Japan univoltine races are reared in Spring (May-June) and bivoltine races in Summer (July-September). In the case of the former, eggs are laid in June and hatch in May next year. Bivoltine eggs are laid in the middle of June, hatch normally :—

In about 15 days when temperature is 75°F.
In about 12 days when temperature is 80°F.
In about 10 days when temperature is 85°F.

If the temperature is higher the results are bad. Eggs are laid by the moths of this second brood about the middle of August and hatch in May next year.

Both these kinds of eggs require to be put in cold storage, *i.e.*, at a temperature of about 40°F. about November till about the middle of April. After the eggs have experienced cold below 40°F., the embryos begin to develop when the temperature goes above 50°F. Fluctuations of temperature injure the developing embryo. For smooth development the eggs should be kept at between 35° to 40°F. and then at about 75°F. for the whole period of incubation.

Cold caves in the Fuji and other mountains were used formerly for hibernation. But at present artificial cold storage has come into practically universal use. Egg-producers have cold storage rooms and such rooms built and run co-operatively are found in many places. All experimental stations are provided with cold storage rooms.

In a village near Mæbashi, in Gumma Prefecture, a large seed-producer never uses cold storage but has a house where the temperature remains constant at about 50°F. He keeps his eggs in this room.

The Gunze Filature at Ayabe, in Fukui Prefecture, which produces large quantities of eggs for the use of its own clients, has built a large reinforced concrete building with double walls and arrangements for changing the air of the rooms continuously but not through direct ventilation. Five hundred moths are made to lay eggs on sheets of cloth 4′ by 3′ in size and these sheets are kept hanging in the rooms in the ordinary temperature of the place which is 62°F. in October, 50°F. in November, 40°-35°F. in December and about 32° to 35°F. in January to April. The double walls of the house prevent quick changes of temperature even if it rises. The results are said to be quite satisfactory.

Where a sufficiently low temperature is available it is made use of in this manner in only a few places. Artificial cold storages give a better control. Besides, storage can be continued and the eggs made to hatch at any time.

33. Artificial hatching of eggs with hydrochloric acid.

Univoltine eggs and hibernating bi-voltine eggs can be made to hatch like polyvoltine eggs by treating them with hydrochloric acid in the following manner. This is resorted to for hatching improved races in the summer and that is how the summer rearing has improved and increased in volume. When 24 to 30 hours old, first of all dip the layings in 2 per cent. solution of formaline for about a minute or so in order to fix them on the paper or cloth on which they are laid. Then dip and keep them for 5 minutes in 15 per cent. solution of hydrochloric acid, preferably in distilled water at 115°F., and then wash well in cold flowing water in order to remove all traces of acid and dry well in shade. The above strength of the hydrochloric acid solution is obtained when its specific gravity indicates 1·075. Bivoltine eggs are kept in this solution for about two minutes longer. If hatching is intended to be delayed, eggs can be kept in cold store at 40°F. after treatment up to 20 days. If the eggs are kept in cold store at 40°F. for 5 days and then treated with acid, hatching is said to be excellent. Delayed hatching of eggs for rearing

in summer and autumn is obtained by the following process:—Submit the eggs when 42 to 45 hours old to cold at 40°F. for 20 to 30 days and then treat with 20 per cent. hydrochloric acid (specific gravity 1·100) at 118°F. for 6 to 7 minutes, which may extend to 8 or 9 minutes. After removal from cold store wait for ½ to 3 hours before treatment. Less than 10 or more than 60 days in cold store is bad.

Celluloid vessels are used for the acid solution but glass vessels can be used (Fig. 49).

Washing tubs are usually of wood and with three chambers in one line. About 50 lbs. hydrochloric acid is required for treating 1,000 egg cards, each card having 28 layings.

34. Artificial hatching of eggs with electricity.

Professor Hori, of the Kyoto Sericultural College, has devised an electrical apparatus for this purpose. Sheets having eggs on them are placed inside a metal drum and positive and negative rays impinge on the sheet on its two surfaces. The treatment is only for a few minutes as detailed below. Professor Hori said that he had been treating two pure bivoltine races of worms, *viz.*, Chinese 101 and Japanese 107 for thirty generations consecutively without any injurious effect and without the races deteriorating in any way.

Eggs laid, say, on 27th September evening can be treated on 28th morning and only for 10 minutes, on the 29th morning for 20 minutes, on the 30th morning for 30 minutes and 30th evening for 40 minutes. The treatment must be completed within 72 hours generally but in the case of European and Chinese races this period may be 120 hours, *i.e.*, 5 days. Hatching can be delayed and regulated for any desired time with the help of cold storage in the following manner:—

After laying, keep the eggs for 36 hours at 75°F and then place in cold store at 40°F. They may be transferred to the cold store at once and need not be taken through gradually decreasing temperatures. Similarly they can be taken out of the cold store and treated when desired.

After 10 to 30 days in the cold store treat for 40 minutes and after 30 days for 30 minutes. Univoltine eggs can be kept in cold store up to 200 days before treatment. Eggs after as many as 100 days in cold store can be taken out, treated and again kept in cold store. These will hatch at any time when taken out.

The electrical apparatus is manufactured by Messrs. Shimadzu Seishakusho Ltd., Kyoto, and one small complete set is quoted by them at Yen 1,980.

35. Conditions affecting reeling quality of cocoons.

Various investigations have been undertaken on this. Some of them are referred to here.

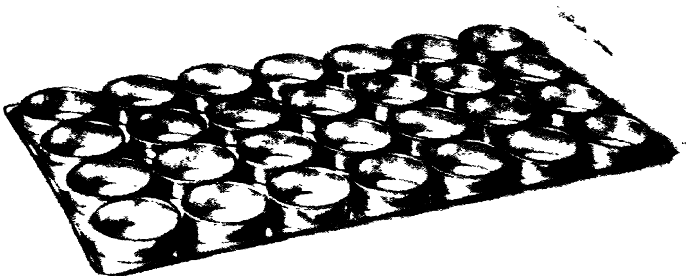


Fig. 48. Ring frame for isolating 28 egg-laying moths on the egg card.

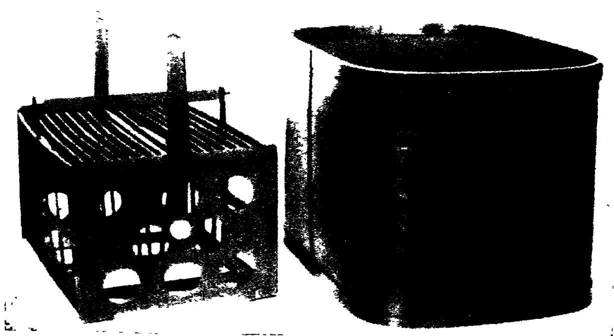


Fig. 49. Celluloid set for treating eggs with hydrochloric acid. Acid solution is made in the vessel. On the left side is the frame in which egg cards are placed and the frame with egg cards is dipped into the solution.

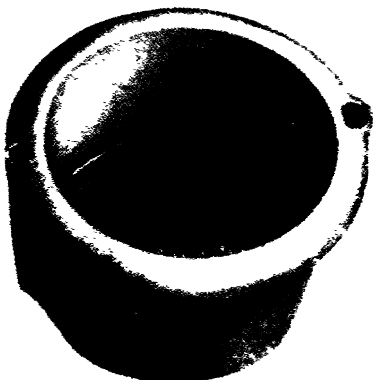


Fig. 50. Basin for cooking cocoons.

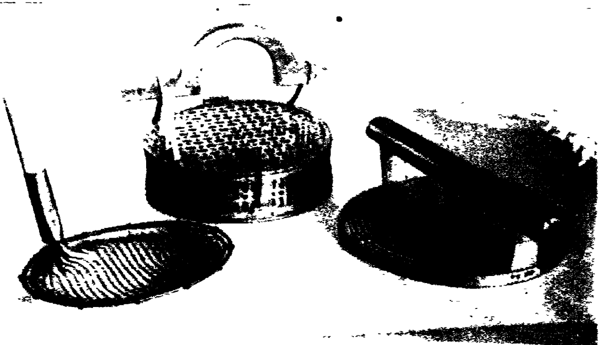


Fig. 51. Cocoon cooking utensils. Brass cage in the middle, its two circular covers are hinged and can be opened. Brass wire disc on the right hand side and stainer on the left.

As regards humidity, Dr. Watanabe, Chemist of the Imperial Sericultural Experimental Station, Nakano, experimented with a cross of bivoltine races, Chinese 101 × Japanese 109, in autumn. Cocoons spun—

(1) At 30°C. and 65 per cent. humidity reeled well.

(2) At 30°C. and 94 per cent. humidity did not reel.

(3) At 20°C. and 75 per cent. humidity reeled very well.

(4) At 20°C. and 94 per cent. humidity reeled badly but better than (2).

The strength of filament of single cocoons (average of the whole filament) was as follows under different humidity :—

Temperature.	Humidity per cent.	Strength in moist condition.	Strength in dry condition.
		Gram.	Gram.
30°C.	50	7·60	8·74
30°C.	94	4·29	7·07

High humidity has, therefore, a very injurious effect. There are more bacteria at a higher humidity and greater solubility of the adhering sericin, at a lower humidity. But the chemical composition and morphological characters of the cocoons spun in different degrees of humidity are similar. He thinks that none of these things are concerned in affecting the reeling quality and that a difference of colloidal state is the real cause. Formalin is kown to change the colloidal state and he made an experiment by spraying formalin in the mounting (spinning) room at the rate of 1 c.c. to 2 c.c. formalin per one cubic meter space. At 30°C. and 94 per cent. humidity cocoons spun under formalin reeled well and those without formalin did not reel. He, however, does not consider these experiments conclusive yet. These experiments are very important and have a close bearing on sericulture in the rainy months in India.

Experiments carried out at the Mæbashi Experimental Station at 86°F. but with different percentages of humidity, *viz.*, 60, 70, 80 and 90 showed that at this temperature 60 per cent. humidity gave the best results. The general conclusion so far at Mæbashi is that for rearing facility, reeling quality and silk content a temperature of 60°F. and 70 per cent. humidity are the best.

As regards chemicals, vessels and water in reeling, any compound of iron and all kinds of metal vessels have been found to be bad and organic putrefaction in reeling water is best avoided. Reeling in dilute organic acids $\frac{1}{100000}$ gives good lustre to the raw silk. Citric and acetic acids are good for this purpose. No metal vessels are used in reeling.

36. Cooking of cocoons.

Cocoons require to be cooked before they can be reeled. In reeling with the *zaguri* and *ashibumi* machines, the cocoons are cooked in the reeling basin itself. In all steam filatures cocoons are cooked separately and cooked cocoons ready for reeling are supplied to the reeling girls.

Cooking of cocoons has now been reduced to a routine and the processes are different if the floating or sunken system of reeling is to be practised. In the sunken system cocoons sink under water in the reeling basin while being reeled and they float in the floating system.

In small filatures cooking is done in wooden cooking troughs. China-ware basins (Fig. 50) are fitted in these troughs for cooking and are fitted with steam jets.

The following is the process for the floating system :—

1. The cocoons put inside a brass wire cage (Fig. 51) and wholly dipped in water at 205°F. and kept there for 30 seconds.
2. Then they are dipped in water with a temperature of about 150°F. for 5 seconds.
3. The cocoons are now poured out of the cage into a bath with a temperature of about 212°F. and held under water with a circular wire disc (Fig. 51) for 3½ minutes. The disc is slowly removed.
4. The cocoons are cooked for about 5 minutes more and the steam is then cut off.
5 The cocoons are now transferred into a wooden trough with water which is just hot enough to allow the hand to be dipped in it. This trough is passed to the reeler.

Such cocoons are filled with water to the extent of about 97 per cent. and float vertically in the reeling basins. They are reeled at a temperature of about 180°F.

In the Kumagaya experimental station there are 50 reeling basins. When all the basins are at work three girls are busy cooking in 8 cooking basins, one carrying out the first two operations in two troughs, and her supply is divided by two girls for the later operations, each making use of one trough for the third and two troughs for the fourth operation.

For the sunken system of reeling the following method is followed. (Fig. 52.)

1. Put the cocoons in the cooking trough at 170°F. or 180°F. and cover them with a circular wooden disc so as to hold the cocoons under water and let in steam and bring the water to boil in about 1½ minutes.
2. Boil for 1 minute and rotate the cover slowly about one turn.
3. Boil for 1 minute and slowly take out the cover and sprinkle cold water over the cocoons with a rose can (about two showers) and put on cover.

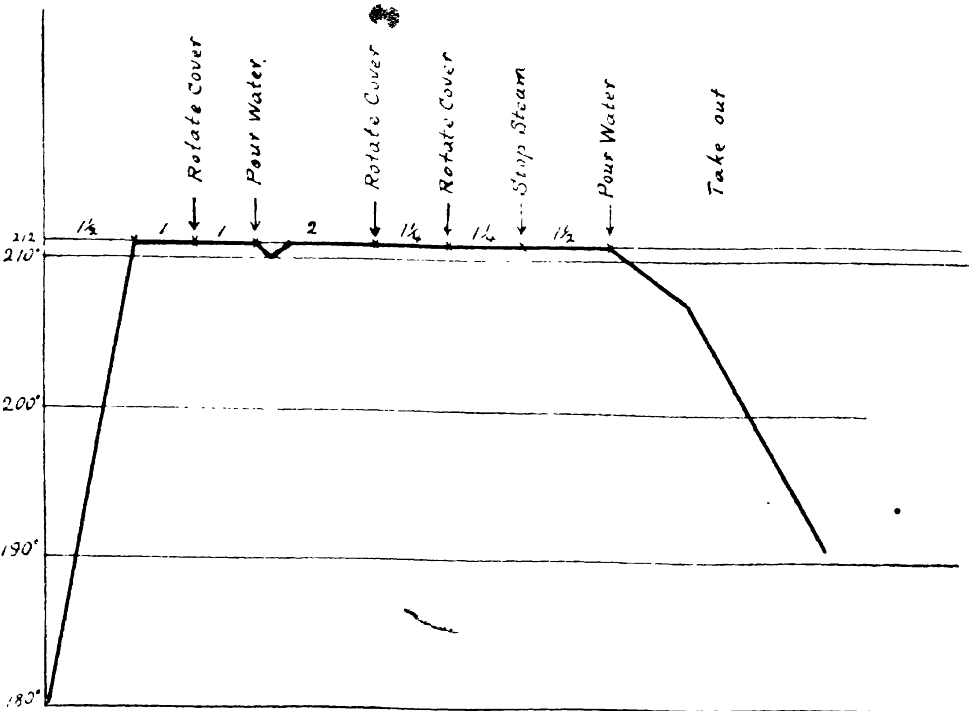


Fig. 52. Chart for cooking for sunken method of reeling. The figures 1, 1½, etc., indicate periods in minutes.

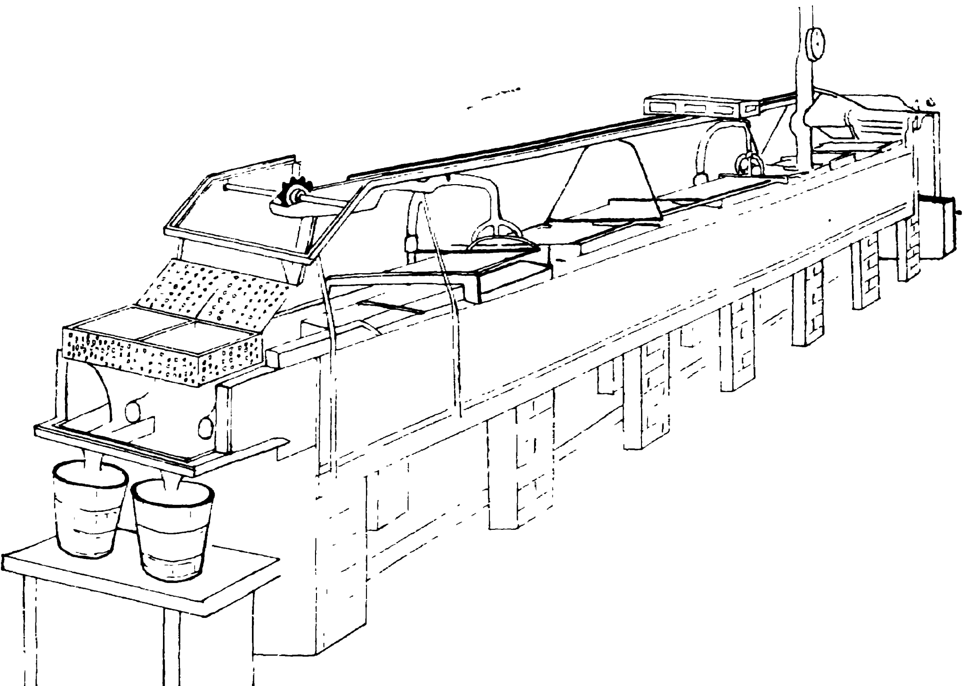


Fig. 53. Continuous cooking plant (Rather diagrammatic).

4. Boil for 1 minute 10 seconds and rotate cover.
5. Same as above.
6. Same as above and stop steam.
7. Press down cover and hold it down for about 1½ minutes and then slowly take it off.
8. Sprinkle cold water (about five showers) and transfer the cocoons into wooden trough with cold water.

Reel at about 150°F.

The process described above for the sunken method is applicable to cocoons rather below normal. In the case of cocoons with good thick silken layer the period of cooking for items 4 to 6 may extend up to about 7 minutes. The cocoons treated in this manner contain more water than those treated for the floating system and sink in the reeling basin.

In the sunken method of reeling, compared with the floating method, the reeling water looks more dirty on account of the greater quantity of pupa oil dissolved in it, the raw silk produced is somewhat darker but softer and cleaner; the raw silk produced is slightly less in quantity but in the end loses less in boiling-off. Therefore this silk fetches a higher price than that produced in the floating system. The sunken method was evolved in and advocated by the Imperial Sericultural Experimental Station. At present about 30 per cent. of the reeling factories follow the sunken system and produce about 40 per cent. of the raw silk in this method.

Cocoons with a thin layer are better reeled by the floating and those with thick layer by the sunken method.

The periods of cooking detailed above vary with the quality of the cocoons. Dead cocoons (in which the worm died before pupation) and spotted or stained cocoons require to be cooked longer and very good cocoons may be ready with shorter periods. The periods of cooking are looked after rather carefully with the help of stop watches.

In all large filatures the cooking is carried out in continuous cooking plants (Fig. 53). The cocoons are put in metal boxes at one end. The boxes are carried over moving chains or screw guides through troughs in which the various processes detailed above are brought about. The cocoons appear at the other end ready cooked. They are taken out and poured into small wooden troughs which are carried on small wheeled carts and distributed to the reelers.

There are various types of machinery devised for cooking cocoons by Furni, Nakahara, Wakuta, Thysow, Choko and others. Choko's is used extensively.

37. Soap for degumming or scouring silk.

The following notes are of work with Dr. Tsunokæ of the Imperial Institute of Silk Industry, Yokohama.

A good scouring soap must have the following properties:—(1) Solubility in water, (2) Degumming power, (3) Odourlessness, (4) Should impart no colour

to the silk, (5) Should give a good lustre to the fibre. Soaps which change colour when kept in store are not good and those which sweat in store are not only bad scouring agents but impart a colour to the silk.

Olive soap has good solubility and good scouring power and imparts no colour to the fibre. Therefore this soap is practically universally used. As regards scouring power the following stand in the order named, *viz.*, olive, tallow, soybean, cotton-seed oil, groundnut oil, pupa oil and castor oil. As regards solubility coconut and castor come after olive oil in the order named. Pupa oil, soybean oil and cotton-seed oil soaps impart a colour to the fibre and are therefore bad.

38. Adosol.

Adosol is a product of natural earth found in Japan which has the property of absorbing moisture and is therefore used in cocoon stores and also sometimes in rearing houses for regulating and keeping down the humidity. It was placed in this form in the market by the Institute of Chemical and Physical Researches, Kamifuji-mae-cho, Hongo-ku, Tokyo. The price is cheap, about 7 yen for one kan ($8\frac{1}{4}$ lbs.) and the stuff can be used for years. All that is necessary is to heat it when in use at intervals of about a week.

A seed manufacturer was observed to use an adosol plant for regulating the humidity of his three rearing rooms. The plant was said to cost Yen 250 including one 1 H. P. motor, necessary pipes and adosol. Adosol worth Yen 21 was sufficient and would last for years. Electric power cost Yen 1·80 per month. The plant was made by Rigaku Kogyo Kabushiki Kaisha, Hongo-ku, Tokyo.

39. Sericinase.

Silkworm pupae are taken out of the cocoons and the moth, as soon as it has broken through the pupal shell, is placed head downwards in a glass tube one end of which is narrowed out and which is put in a test tube. The moth in trying to push through the tube ejects a clear fluid which it uses under natural conditions in softening the cocoon at the time of emergence. This fluid is collected in this manner from many moths, and when used with ordinary water in the proportion of 1 c.c. to 1000 c.c. of water, forms a very efficient reeling water for testing filament lengths of even live seed cocoons without injuring the pupæ in any way. Cocoons dipped and soaked for 20 to 30 minutes in this solution reel well.

PART V.—ADMINISTRATION AND ORGANISATION.

40. The Imperial or national government.

In the very first year of the reign of Emperor Meiji (1868) Government provided an institute for egg production. In 1870 a Sericultural Department was created. In 1872 a model filature on the French system was started and in 1877 a model mill for spun silk. Laws and regulations were passed for controlling diseases and conditioning and export of silk. Institutes were provided for study and examination of eggs, worms, mulberry and reeling. Teaching institutes were developed side by side. Where necessary, subsidies were given and monetary help rendered liberally.

At present the Ministry of Forestry and Agriculture has charge of the raw silk industry. The silk manufacturing industry is under the Minister of Commerce and Industry. Sericultural education is under the Minister of Education who controls the Sericultural Colleges at Tokyo, Ueda and Kyoto.

Under the Minister for Forestry and Agriculture until lately the Department of Sericulture formed a part of the Bureau of Agriculture. Now a separate Sericultural Bureau has been set up with a Director of its own. This Bureau has two sections *viz* :—

1. *Sangyoka* dealing with mulberry cultivation, egg-production, worms, rearing, prevention of diseases, etc.
2. *Kenshika* dealing with cocoons, reeling, raw silk, conditioning houses, etc.

Work of the Ministry of Agriculture and Forestry for the raw silk industry.

1. Enforcement of the Sericultural Law.

(*a*) *Prevention of diseases.* For inspection of eggs Government directs all prefectures to establish controlling stations and to enforce rules according to law.

The State Treasury can help up to half of the whole expenditure. At present the national subsidy is 173,250 yen, *i.e.*, about 3,766 yen on the average for each prefecture. The total expenditure of all the Controlling Stations (*Torishi-mari Jo*) in Japan in round figures is 2,500,000 yen.

(*b*) *Inspection and supervision of egg-production.* The examination is to be carried out by the Prefectures in their egg-examining establishments under controlling stations but the State supervises the work, calls for reports and results and occasionally despatches officials for supervision.

(*c*) *Control and guidance of guilds and associations.* The local guilds and associations are under the local Governor. But the formation and even dissolution of many require the sanction of the Minister.

2. Encouragement and improvement of sericultural industry.

(a) *Encouragement and improvement of mulberry.* Replanting of old mulberry is very expensive and a heavy burden on farmers if done at one time. The State is helping with subsidies since the 40th Meiji Era (1908). The national subsidy is 22,000 yen and the total expenditure of all prefectures is 611,000 yen.

(b) *Encouragement of production and distribution of superior parent seed* (*original seed*). The Prefectural Experimental Stations (*Sangyo Shikenjo*) are engaged in preparing improved parent seed which is supplied to egg-producers usually free of cost. The State helps the prefectures to maintain these *Sangyo Shikenjos* since 44th Meiji (1912). In 3rd Showa (1928) the State subsidy was 37,000 yen and the total expenditure of all the prefectures in round figures was 2,500,000 yen.

(c) *Help to the* (*Sanshigyo Dogyo Kumiai Chuokai*) *Raw Silk Association of Japan* which looks after the silk trade, sends experts to America and investigates conditions of consumption, etc.

(d) *Investigations of defects.* (i) The State directs suitable prefectures or bodies to investigate particular conditions and problems. The national subsidy for this purpose is Yen 1,005.

(ii) Investigation for the working and proper observation of the law. National subsidy is Yen 1,000.

3 Encouragement of trade in dry cocoons.

The raw cocoon buying period being short, filatures are required to invest large amounts of money at once and in a short period and also there is competitive and speculative purchase. To remedy these defects the State is helping with money to have drying plants and dry cocoon store houses under certain conditions. Associations of Sericulturists receive grants of 40 per cent. of the expenditure for this purpose. Up to 1928 the annual budget for this purpose was 604,800 yen and that of 1929 is Yen 765,656.

4. Investigation of the sericultural industry.

Investigations are always being made at home and abroad. Every year suitable men are sent abroad and the Raw Silk Association is helped for this purpose. In order to investigate the conditions at home regarding mulberry, eggs, rearing, reeling and trade in cocoons and silk, the Sericultural Bureau maintains a special department which publishes facts, figures and recommendations and keeps all concerned informed of them.

5. Relief for damage to mulberry by pests or hail.

The Government issues loans at a low interest from Savings Bank Deposits. A loan of Yen 8,330,000 was given in 1927.

6. Emergency loans to Sericulturists.

When the price of cocoons falls very low, the sericulturists get loans at low interest from Savings Bank Deposits.

In 1928 when the price of autumn cocoons went down very low, being about one-third that of spring cocoons, the Ministry of Agriculture and Forestry in consultation with the Finance Department issued about Yen 50,000,000 at low interest.

7. Maintenance of Sericultural Experimental Stations.

The main Station at Nakano was established in the 44th year of Meiji era (1911) and it has now six branch Stations in different parts of Japan. The Total budget of these Stations was Yen 460,000 in 1928.

8. Conditioning of silk for Export.

For this purpose the conditioning house is maintained at Yokohama. (The one at Kobe was under the Municipality and has recently been taken over by the State). The conditioning house, apart from conditioning the silk for export, carries out quality tests free of cost and makes out certificates which on the one hand enable manufacturers to know and remedy defects and on the other help trade and transactions in the Yokohama Silk Exchange. The budget for 1928 was Yen 540,000.

9. Sericultural Committee.

Rises in wages and apprehended competition of rayon and production in other countries, especially China, led the Government to establish a Committee in 1927 to look after the welfare of the raw silk industry with a view to improve efficiency and reduce cost of production. The Minister of Agriculture and Forestry is the President of the Committee which has less than 30 members who are officials and non-officials versed in the industry. This Committee has three Sub-committees. The first deals with the improvement of mulberry, of methods of egg production and rearing and of the cocoon trade as well as the encouragement of rearing. The second deals with the improvement of the silk trade. The third deals with experimental and testing institutions and stability of the price of cocoons and silk.

The Government is paying attention to the following as parts of its future policy :—

(1) Mulberry gardens. It was ascertained in 1925 that about 37 per cent. of the area under mulberry needed replanting or improvement. For this purpose Government decided to give a special subsidy. The budget grant for this purpose in 1929 was Yen 300,000.

(2) Co-operation in the sale of cocoons, purchase of eggs, manures, etc., rearing young worms and employment of experts by the rearers.

(3) Improvement in the methods of rearing in summer and autumn.

(4) Proper investigation of the economics of rearing with a view to lessening the cost of rearing.

(5) Prevention of damage by frost to mulberry. For this investigation Government provided Yen 36,000 in the budget for 1929.

(6) Improvement of the filature industry.

(*a*) For investigation of the economics of the reeling industry (for instance, the best form of this enterprise, cost of production, system of sale, etc.), Government sanctioned Yen 41,000 in the budget for 1929.

(*b*) Improvement of filature machinery. Silk has now to compete with rayon and in America the demand is for a high quality of the raw silk. Government sees the necessity of improving the machinery which will cheapen production and at the same time improve quality.

(*c*) Co-operation in the filature industry. Co-operative filatures have several merits over private filatures but the former are now only small factories with about 68 basins on the average and rather imperfect equipment.

(*d*) Reforms regarding financial assistance for the purchase of cocoons which are the raw materials for the filature industry but have to be bought for the whole year in a very short time. It takes long to reel them and during that time the filature has to bear charges and risk fluctuations in the price of the raw silk. From its nature the industry requires a large capital which has frequently to be borrowed at high rates of interest. It is very necessary to effect reforms in this matter.

(*e*) Grading or classification of cocoons and raw silk. It is not very easy to judge the commercial value of cocoons and raw silk. Absence of a proper and generally accepted system of grading is disadvantageous both to buyers and sellers and frequently leads to unfair trade.

The Imperial Sericultural Experiment Station at Nakano has been studying the question of grading cocoons since the 15th Taisho year (1926). As regards grading of raw silk, the Yokohama Conditioning House and the Imperial Institute of Silk Industry are engaged in this study and the Government gives Yen 37,000 per year to the Raw Silk Association which is engaged in a discussion with the Silk Association of America with a view to bringing about an acceptable system of grading.

(*f*) Encouragement of the trade in cocoons in "conditioned" (*i.e.*, dried) state. At present only about 2 per cent. of the cocoons is sold in "dry" condition.

(*g*) Stabilization of the price of raw silk. Great fluctuations in the price of raw silk involve filature owners in loss and also disorganise the rearing industry when the price of cocoons falls low.

(*h*) Improvement in the technique of reeling. For the study and investigation of this, the Government is enlarging the reeling department of the Imperial Experiment Station at Nakano (as it did the rearing department some time back) and has provided Yen 100,000 in the budget of 1929.

41. The Prefectural Governments.

Forty-five out of the 47 prefectures in Japan, that is, all the prefectures except Osaka and Saga, have each a Sericultural Department. In order to explain the organisation and work of this department I take Saitama Prefecture as an example. One of the three Assistant Governors under the Governor is in charge of this department with a whole-time secretary (*Sanshika*) who may be either a civil or technical officer. The *Sanshika* has a Sericulturist (called *Jocho*) as adviser on all sericultural matters and also as director of all sericultural organisations in this prefecture. These organisations are of two kinds, *viz.* :—(1) Controlling Stations (*Torishi mari Jo*), (2) Experiment Stations (*Sangyo Shikenjo*).

Controlling Stations.

The functions are :—

(1) Control of diseases. This involves supervision of the rearing of all licensed egg-producers, examination of moths and passing of eggs and also supervision of the sale of eggs. For the examination of moths, which has to be carried out microscopically, there are stations all over the prefecture.

(2) Investigation and encouragement of all matters for the improvement of the sericultural industry of the prefecture.

(3) Maintenance of demonstration mulberry gardens. There is one such garden in each *Gun* (county) of this prefecture (and of almost all prefectures).

(4) Formation, guidance and supervision of all kinds of guilds, associations and co-operative societies in the prefecture.

(5) General guidance of sericultural experts and teachers connected with the societies and guilds in the prefecture.

(6) Collection, preparation and publication of statistics regarding the sericultural industry of the prefecture. This is done in co-operation with the village headmen.

(7) Control of the trade in seed, raw cocoons and mulberry seedlings and grafts.

In the whole of Japan in 1928 there were 206 main and 137 branch controlling stations with 66 Experts and 767 Assistant Experts and 234 clerks. The number of temporary hands, mostly microscopists, engaged during the working season was 69,559. These stations dealt with 7,743 egg-producing establishments, 40,434 egg-traders, 105,337 cocoon-traders and 63,868 mulberry nursery men, besides guilds, societies and associations.

Experiment-Stations (Sangyo Shikenjo).

Forty-five out of the 47 prefectures have experiment stations of their own. One (Gifu) has 3 stations, another (Ibaraki) has two and the rest have one each. These 48 prefectural stations have 21 branch stations. (The Imperial Experiment Station and its six branches are not included in this number).

The functions of the Prefectural Experiment Stations are :—

(1) Research work in sericulture, mulberry and reeling. Sericulture includes local study of varieties of silkworms and methods of rearing. Similarly, mulberry culture includes study of varieties of mulberry, cross-breeding and production of new varieties, grafting, manurial trials and methods of cultivation. Research in reeling mainly consists in finding out the reeling qualities of cocoons with the necessary testing of the raw silk produced. Some experimental stations carry out testing of samples of cocoons for the cocoon trade, each test sample being 400 *momme* (about 3 lbs) of cocoons by weight. Filature owners and co-operative societies send the samples. Reeling is sometimes undertaken of cocoons of sericulturists on payment.

(2) Production of the parent seed or original seed for the egg-producers. The Experimental Stations are, however, not able to cope with this demand. Therefore the egg-producers are allowed to rear parent seed under the direction of the controlling stations. About 40 per cent. of the demand in parent seed is supplied by the Experimental Stations.

(3) Training of students. In some stations there are as many as 100 students.

(4) Lectures and talks to the public. Visits of the public interested in any branch of the sericultural industry are encouraged and the members of the staff also visit and lecture at different places.

(5) In addition to training given to regular students, short courses of training are given occasionally in mulberry cultivation, grafting, reeling and testing of raw silk.

(6) Demonstration mulberry gardens are usually maintained by the staff of the Experimental Stations.

(7) Mulberry seeds and seedlings are distributed.

(8) Chemical tests are carried out for farmers.

In 1928 the Prefectural Experiment Stations and their branches were staffed with 99 Experts, 256 Assistant Experts and 72 clerks. Their detailed organisation and work will be found in Part VI.

Sericultural Committees in Prefectures.

Some of the prefectures have Sericultural Committees (*Sanshi in Kai*) or silk investigation committees, with both officials and outsiders as members and each with a budget of its own varying in amount from 200 yen to 1000 yen.

Work in the Prefectures.

1. *Improvement of mulberry.* (*a*) There are agricultural and forest specialists and assistant specialists in the prefectural offices who guide and encourage mulberry cultivation.

(*b*) Subsidies are given for the undermentioned enterprises to municipal or rural agricultural committees, sericultural associations or other bodies :—

(1) Distribution of young mulberry plants.

(2) Establishment of mulberry gardens and nurseries for improving mulberry.

(3) Replanting of old or decayed mulberry.

(4) Establishment of mulberry gardens for spring and autumn rearing separately.

(5) Improvement of "high plantation", *i.e.*, mulberry other than bushes.

(6) Establishment of late varieties of mulberry, with a view to improving summer and autumn rearing.

(7) Employment of specialists by various organisations and village societies with the aim of improving mulberry.

(8) Establishment of demonstration gardens.

(9) Mulberry exhibitions and shows.

(10) Nursery shows.

(*c*) The following steps are taken by the Imperial Sericultural Experiment Station :—

(1) Establishment of gardens for "stocks" and "scions" and distribution of stocks and scions among garden owners.

(2) Improvement of mulberry plants and distribution of improved plants either free of cost or at cost price to garden owners.

(3) Distribution of mulberry free of cost.

(4) Demonstration of grafting methods to garden owners and training of specialists.

(5) Investigation of varieties, nursery and cultivation methods and manures.

(*d*) Lectures are arranged for on grafting, nursery, prevention of epidemic diseases, fungi, moulds and insects and general improvement of mulberry gardens.

(*e*) Determination of varieties suitable for different areas.

(*f*) Regulations concerning the examination and grading and trade of young mulberry plants which are done by Prefectural orders.

(*g*) Encouragement of societies and associations of nursery owners and leaf traders for eradicating bad customs and defects in the trade. Sometimes subsidies are given for this purpose.

(*h*) Grants of loans at low rates of interest to improve gardens attacked by diseases and pests. The Sericultural department of the Prefectures is the granting authority. Pecuniary help is also given to those who have borrowed money from agricultural or industrial banks for improvement of mulberry gardens.

(*i*) Organisation of Committees for the prevention and eradication of mulberry diseases.

2. *Improvement of rearing.* (*a*) Some specialists (usually called experts or *gishi*) and assistant specialists (*gi-shu*) are employed in the prefectural office, in the experimental stations and in every county for improving rearing methods.

(*b*) Subsidies are given to societies and organisations for co-operative rearing of young worms and for employing demonstrators for this purpose.

(*c*) Some monetary help is given to agricultural associations of counties and towns which employ sericultural demonstrators.

(*d*) Some pecuniary help is given to the Federation of Sericultural Associations and guilds for:--(1) encouraging the formation of sericultural associations in villages and counties, (2) encouraging the employment of specialists by sericultural associations, (3) equipment, lectures and demonstrations in the sericultural societies, (4) purchase of silkworm seed suitable for the locality co-operatively and establishment of public mulberry gardens for co-operative rearing of young worms.

When the league of sericultural associations encourages co-operative sale of cocoons, it is given some pecuniary help by the Imperial Government.

(*e*) Some pecuniary help is rendered to the Silk Association for the employment of specialists to encourage the establishment of sericultural associations and hold demonstrations.

(*f*) Encouragement of the trade of cocoons in dried condition. The Ministry of Forestry and Agriculture gives a grant for this purpose and in addition to this the Prefectural Governments also may render some pecuniary help. There are regulations for the award of a subsidy to members of sericultural associations who entrust a definite amount of cocoons for sale to the following bodies, *viz.*, (1) those which have been given a subsidy by the Ministry of Forestry and Agriculture under regulations for encouraging co-operative drying and warehousing of cocoons and (2) agricultural warehouses having the necessary equipment for drying and storing cocoons.

3. *Improvement of races of silkworms* (*San-shu*). (*a*) Prefectures employ specialists for making the *san-shu* (improved eggs).

(*b*) Some subsidy is given to prefectural *san-shu* co-operative societies on condition that (1) improvement will be effected in the varieties of silkworms and (2) specialists will be employed for work, demonstration and lectures on this subject.

4. *Improvement of reeling* (*Seishi*). (*a*) Encouragement of the employment of female specialists for teaching reeler girls.

(*b*) Demonstration in reeling for improving the knowledge and skill of reeler girls.

(*c*) Investigation of (*zaguri ito*) reeling of bad cocoons and (*tamaito*) double cocoons by co-operative societies and sericultural associations and giving of monetary help for improvement.

(*d*) Reward or gratuity in recognition of good work to those who have worked for many years as reelers.

PART VI. INSTITUTIONS FOR RESEARCH AND EXPERIMENT.

42. Universities and colleges.

The four Imperial Universities having a Faculty of Agriculture carry on research work in Sericulture. The first and very important research work on biology, heredity and diseases of silkworms was performed in the Agriculture Faculty of the Tokyo Imperial University and numerous papers are to be found in its Journals and Bulletins. As a matter of fact, this pioneer work laid the scientific foundation of the present industry.

The research work carried on by the staff of the three Sericultural Colleges at Tokyo, Ueda and Kyoto has been referred to in Part VII. Each College publishes bulletins of its own.

43. Sericultural experiment stations (Sangyo Shikenjo).

These institutions are meant wholly for research and experiment on sericultural subjects. The principal one is that at Nakano maintained by the Imperial Government and called *The Imperial Japanese Sericultural Experiment Station.* It has the following departments :—

1. Mulberry department. Staff-Experts 3 ; Asst. Experts 3 ; Assistants 6.

2. Biological department dealing with heredity, hybridization, physiology and voltinism of silkworms, study of rearing methods and of relations of silkworms to environments, and production and distribution of eggs of superior races of worms. Staff-Experts 4 ; Asst. Experts 5 ; Assistants 10.

3. Pathological department dealing with diseases of silkworms. Staff-Experts 4 ; Asst. Expert 1 ; Assistants 5.

4. Filature department dealing with drying and cooking methods of cocoons, reeling qualities of cocoons, grading of cocoons, reeling methods, conditioning, testing and classification of raw silk, physical properties of raw silk and study of reeling machinery. Staff-Experts 4 ; Asst. Experts 3 ; Assistants 25.

5. Chemical department dealing with manures, mulberry, reeling water and other questions relative to sericulture and silk industry. Staff-Experts 3 ; Asst. Experts 3 ; Assistants 10.

6. General department dealing with matters which do not come under any of the above, under the charge of the Director of the Station. Besides the above there is an Entomologist and a Mycologist.

Special work is taken up by this station and carried on until completed. A few of the present items are :—

(i) Grading of cocoons. A definite system of grading is essential for the trade in cocoons. For this investigation a special temporary budget was sanctioned, 37,722 yen in 1927 and 21,362 yen in 1928.

(ii) Study and removal of the disadvantages in summer and autumn rearing. By resorting to artificial hatching of eggs there has been a great improvement in rearing in summer and autumn which is now about 51 per cent. of the total annual rearing. On account of unfavourable climatic conditions in these seasons the worms suffer from diseases which are estimated to cause a loss of about 50,000,000 yen to 100,000,000 yen. Prevention of this loss is an urgent necessity. For this investigation a special budget is sanctioned. It was 9,364 yen in 1927 and 35,587 yen in 1928. The present items of this investigation are :—

(*a*) Relation and influence of temperature and humidity on the health of the worms. For this purpose up-to-date concrete buildings have been built and fitted with expensive plant in order to bring about and maintain different temperatures and humidity in different rooms.

(*b*) Relation of mulberry leaves and worms.

(*c*) Relation of eggs and resultant worms.

Propaganda is also undertaken for which the staff frequently visit different places and deliver lectures.

Training is given in the improved methods effected in the station, in drying and cooking cocoons, reeling, rearing and mulberry cultivation.

Achievements of this Station. (i) *Worms.* This station has done excellent work in unifying races of worms for rearing. About 1913 there were about 1000 kinds of worms producing different kinds of cocoons. By 1926 about 71·4 per cent. of the rearing was from eggs which originated from this station.

By rearing and crossing various kinds of worms it advocated first generation crosses of Chinese, Italian and Japanese races for ordinary rearers and at present such crosses represent about 99·4 per cent. of the spring rearing and about 79·6 per cent. of the summer and autumn rearing.

It has contributed very much to improving the quality of cocoons.

(ii) *Mulberry.* It has separated the varieties of mulberry and found varieties suitable for spring, summer and autumn and is trying to popularise them. Since 11th Taisho (1922), it has prepared and distributed more than 77,000 grafts.

(iii) *Reeling.* It has contributed a good deal in improving the reeling industry. It studied different methods of cooking cocoons. The sinking method referred to in section 36 is gradually replacing the floating method.

The Branch Stations perform experiments with mulberry, silkworms and method of rearing, produce and distribute eggs, carry out experimental work on behalf of local rearers and give lectures on different subjects connected with sericulture.

(1) Maebashi Branch has on the staff 1 Asst. Expert and 3 Assistants;

(2) Ayabe Branch has 2 Asst. Experts and 6 Assistants.

(3) Fukushima Branch has 1 Expert, 2 Asst. Experts and 7 Assistants.

(4) Ichinomyia Branch has 1 Asst. Expert and 9 Assistants.

(5) Kumomoto Branch has 1 Expert, 4 Asst. Experts and 3 Assistants.

(6) Matsumoto Branch has 1 Expert, 4 Asst. Experts and 7 Assistants.

The annual budget of the Nakano Station, including the branches, is at present 460,000 yen. Formerly there used to be a special grant for sending experts to foreign countries. As, however, practically all the experts have visited foreign countries this special grant has now been stopped.

The main and the branch stations have ample buildings, laboratories, rearing houses, cold storage arrangements, reeling plants, testing apparatus and mulberry plantations.

All experts are given a budget of 3,000 yen each per year and Assistant Experts 1,500 yen each which they can spend on apparatus, chemicals and books as they find necessary. This applies to all scientific departments. What has struck me most is the amount of leisure which the Experts and Asst. Experts have. They take up a particular problem and work at it leisurely with ample time to think and study.

The Prefectural Experiment Stations. The Stations of the Saitama Prefecture are taken as example. The main Station is at Kumagaya with a branch at Chichibu.

Kumagaya Experimental Station has the following departments :---

1. The Sericultural Department. The Chief Expert of the Station is in charge of it. There are one more Expert, four Assistant Experts, four Assistants, ten temporary Assistants. The assistants are divided among the different sections to help the experts and assistant experts.

This department also has charge of the students. The students are sons of cultivators and rearers. The minimum qualification for Lower Grade students is completion of the Primary School course. Higher Grade students are required to have undergone training in a Sericultural or Agricultural School. Equal numbers of Higher and Lower Grade students are taken. They are admitted after an entrance examination, the first 39 being taken. Usually about 60 to 70 apply and sit for the entrance examination. The period of training is one year in both theory and practice, rearing work from April to September, work in mulberry cultivation especially from October onwards and theoretical classes, reeling and raw silk testing especially in winter till about February. The students are provided with a free boarding house and paid a stipend of Yen 9 per month by the Prefectural Government. They spend 10 to 12 yen a month for food and therefore have to get some help from home. After training most of them work independently, some become village teachers or find employment as experts under village co-operative societies or in the controlling stations.

2. The Moricultural department has one Expert in charge, five Assistant Experts, *viz.*, two for chemical work, one for entomological work, one for physiological work and one for cultivation. Seven assistants and ten casual assistants help the expert and assistant experts.

3. The Filature department has one Assistant Expert in charge, four Assistant Experts for the different sections of sorting, drying, cooking, reeling, re-reeling and testing, three women Assistant Experts to help the above in reeling, re-reeling, testing, double-cocoon reeling and floss silk making, and one mechanical foreman in charge of the boiler.

The Station is provided with ample buildings, rearing houses, laboratories, mulberry areas, cold storage, and reeling, re-reeling and testing appliances. All the Prefectural Experimental Stations are more or less on this plan. Some have very efficient ammonia plants for cold storage and also well-fitted buildings for work with regulated temperature and humidity.

The branch station at Chichibu is in charge of one Expert with three Assistant Experts (one for experiments, one for mulberry and one for seed production), three assistants and one clerk.

4. Administrative department—

For the administration of the Station the Director has a separate office with three clerks. The Director's headquarters for district work are also located in this station and this is looked upon as the Administrative branch of the station itself. This branch has one Expert in charge with 6 clerks for general work, one Assistant Expert with 3 clerks for work in connection with co-operative societies, one Assistant Expert with two assistants for work in connection with controlling stations, one man representing the Sericultural Association of Japan (*Dai Nihon San Shi Kai*) and working for propaganda and collection of statistics as regards mulberry, rearing, etc., two Assistant Experts with 4 clerks looking after the finances of the co-operative associations, one Expert for work in connection with co-operative societies for developing the trade in dried cocoons, and one Assistant Expert looking after co-operation in reeling and work in connection with the Government subsidy for reeling; otherwise reeling is now-a-days left to private enterprise.

In the various sericultural experimental stations the number of officers devoting their whole time to sericultural research and experiment is about 40 and that of those carrying on such research along with connected works is about 100; 270 Assistant Experts in the various sericultural experiment stations are also engaged in work which contributes to the advancement of the sericultural industry.

44. Other Institutions.

The conditioning houses, having the opportunity of carrying out numerous tests, are provided with a staff for research work on :— (*a*) the various qualities of raw silk, (*b*) apparatus and machines in silk conditioning and testing, (*c*) standardization of skeins, packing, etc., and (*d*) grading and classification of raw silk.

In the 38th year of Meiji Era (1906) standard methods of skein making and packing were enforced and 303 persons were given practical training and 196 a training of a still higher order.

The Imperial Institute of Silk Industry is at present located in the same building and working in co-operation with the Imperial Silk Conditioning House mainly on the properties of raw silk in all its stages up to the production of the finished woven goods, including dyeing, printing and finishing. It has three departments, *viz.*, (1) one for chemical and physical properties of natural and artificial silks, (2) one for weaving, and (3) one for scouring, finishing and printing. The items of investigation at present are the following :—

(*a*) Grading and classification of raw silk which is very necessary for conveniences of trade.

(*b*) Machinery for raw silk testing. The budget for this in Showa 3rd year (1928) was 27,441 yen.

(*c*) Storage methods of raw silk in order to prevent deterioration in the store. The budget for this was 37,000 yen in 1927 and 26,000 yen in 1928. The Imperial Institute of Silk Industry is now having a new building of its own and up-to-date machinery and fittings and will take about two years more to be ready.

The staff of the technical and industrial colleges and schools also carry on research on sericultural subjects and are responsible for several delicate appliances and improvements in reeling machinery.

Apart from these Government institutions several large reeling concerns maintain research stations for producing desirable races of worms, the eggs of which they do not allow to go out. Such concerns also carry on experiments in evolving better reeling machinery which they protect by patents and which cannot therefore be used by other concerns. Several such patented parts were met with in some of the filatures visited. It was announced on the 24th October 1929 that the Raw Silk Institute of the Hara Gomei Co., Yokohama., had perfected an automatic reeling machine which would reduce the cost of reeling to half the present rates and at the same time produce a high grade silk. It was claimed that about 50,000 sets would do the work of the 300,000 basins now in use.

45. The scientific service.

Mention has frequently been made of experts and assistant experts. Their pay and pension are indicated below :

	Yen	
Pay of an assistant expert on entry	75	per month.
After 1½ years	85	„
„ 1½ „	95	„
„ 1½ „	100	„
Then he may become an expert on	1,400	per year.
and get after 2 years	1,600	„
„ 2 „	1,800	„
„ 3 „	2,000	„
„ 3 „	2,400	„
„ 3 „	2,700	„
„ 3 „	3,100	„
„ 3 „	3,400	„

For reasons of economy further increase may stop here. The other higher grades, usually filled by selection, are 3,800 yen, 4,100 yen and 4,500 yen, which is the maximum per year. Experts usually retire at 3,400 yen or 3,800 yen.

In addition to the pay a bonus equivalent to two months' pay is given every year. Formerly the bonus was equal to one month's pay. There is also a system of granting medals and certificates after definite periods of service.

Pension is allowed at one-third of the pay after 15 years of service and an addition of $\frac{1}{150}$ of the pay is made for each year of additional service after 15 years.

Experts and in some cases assistant experts also are sent out to foreign countries as a matter of routine and budget provision is made for the purpose. In the case of the Sericultural department the rules are very liberal. The entire pay is given to the family and the whole of the expenditure is met by Government at first class rates from the time of departure from and till return to Japan. In education and other departments half of the pay is given to the family. It is not a question of an expert asking for study leave abroad but the decision of the Government which has to be carried out. The expert is left free in every respect to utilise his time to the best advantage.

PART VII. SERICULTURAL EDUCATION AND TRAINING.

46. SERICULTURAL EDUCATION—SCHOOLS AND COLLEGES.

Sericultural education and training can be commenced only after the completion of the compulsory primary course. A short description of primary and higher schools is given here in order to explain how sericultural courses are combined with the general courses of education.

Primary Schools (*Sho-gakko*). Primary education is compulsory for all boys and girls in Japan and is free. Large buildings which attract the eye throughout the country are all school buildings with ample rooms and play-grounds, and sufficient apparatus, models, specimens and charts for teaching science and Natural History. Buildings of all educational institutions in Japan are on a commendably ample scale.

Boys and girls have to join a primary school in their seventh year according to Japanese calculation but actually in their sixth year. The primary school course lasts for six years. Boys and girls may study together only in the lower two or three classes of some primary schools but usually they are in separate schools or classes. The school hours are usually from 8 A.M. to 2 P.M.

Physical exercises are carried out during these hours, either in the open air if the climate allows this or in specially provided large halls. Excursions even to distant places about once a month are carried out as a routine.

The Primary School Course comprises moral training, music, drawing and painting, manual work *viz.*, paper-modelling, clay-modelling, carpentry and sewing (for girls only), reading, writing, composition, arithmetic, botany, zoology, elementary physics and chemistry, Japanese history, geography (of Japan as well as of the world), physical exercise, drill, games and sports.

The Zoology course includes the life-history of the silkworm.

Higher Primary Schools, with a course extending over two years are meant for those boys and girls who do not go to a Middle School. Some of the subjects of the Middle Schools are condensed into this course.

Middle Schools. After the completion of the primary school course boys and girls go to a Middle School for five years. Sericultural Schools and Agricultural Schools are of the same standard as the Middle Schools and actually combine the curriculum of the Middle Schools with extended and detailed courses in Sericulture or Agriculture as the case may be. Again, Agricultural Schools teach Sericulture also and similarly Sericultural Schools teach Agriculture also. In many Middle Schools both for boys and girls, even in towns like Tokyo, silkworm rearing is taught and for this purpose rearing houses are provided. In the Agricultural Schools better rearing houses are provided for silkworms than in Middle Schools. The courses of study of Boy's (*Chu-gakko*) and Girl's Middle School (*Jo-gakko*)

comprise 1. Moral training. 2. Language, Japanese and old Chinese, reading, writing, grammar and composition. 3. Foreign language, English and French or German for boys and English or French for girls. 4. Mathematics. 5. History and Geography. 6. Science, *viz.*, Botany and Zoology; Physics and Chemistry; Physiology and Hygiene (for girls only). 7. Business course, *e.g.*, agriculture, carpentry and smithy, commerce and book-keeping (for boys only). 8. Law and economics (for boys only.) 9. Drawing for boys and drawing and painting for girls. 10. Music (for girls only). 11. Physical exercises, drill, gymnastics, fencing, wrestling and military exercise for boys. Drill and exercises in drill and also games and sports for girls. 12. Domestic science, house, food and clothing for girls only. 13. Tailoring, cutting, sewing, mending for girls only.

For teaching botany and zoology every school is provided on an ample scale with charts, diagrams, models, anatomical models and sketches and properly mounted museum specimens. Study of the life-history of silkworms by actually rearing them is a regular feature. Gardening and poultry keeping are also carried out.

For physics and chemistry properly fitted practical class rooms are provided and the laboratories of each school are stocked with all necessary apparatus including radio sets.

There are workshops for pottery, carpentry and smithy.

Physical exercises are carried out as a routine and large gymnasiums and halls are provided in each school for the purpose.

Excursions to places of interest practically all over Japan are undertaken once every month as a routine.

High Schools (Koto-gakko) and Universities (Dai-gakko). From the Middle Schools boys aiming at University education go to a High School for three years and then enter the University for one of the following six faculties, *viz.*, Agriculture, Law, Science, Technology, Literature or Medicine. The University term is four years in medicine and three years in the other faculties. Agricultural High Schools provide for sericultural education. The one at Kogoshima has a well organised course. The four Imperial Universities in Japan, *viz.*, Tokyo, Kyoto, Kyushu and Hokkaido, having Agricultural faculties provide for regular sericultural courses.

Sericultural Schools. A detailed description of one Sericultural School is given. There are sixteen such schools in Japan.

The Annaka Sericultural School. It was founded in 1913 and has three courses of training (1) for 5 years (2) for 3 years (3) short course for 6 months. Candidates for (1) must be above 12 years of age and must have passed the primary school course. Those for (2) must be 14 years old or older and must have passed the higher primary course. Those for (3) must be 14 years old or older and must have passed the primary school course. The number of admissions is limited to 320 in (1) and (2) and to 30 in (3).

About 85 per cent. of the boys admitted come from agriculturist and sericulturist families and the records between 1915 and 1928 show that about 69 per cent. of the boys went back to their family occupation, *viz.*, agriculture, after completing their education in this school. The students have to pay Yen 5·50 per month as fees (*viz.*, school 3 yen, alumni club 0·50 yen, travelling 1 yen and stationery 1 yen), to purchase books worth 69·21 yen for the full course (1) and worth 56·75 yen for course (2), to meet occasional expenses amounting to 34·15 yen for uniform, fencing dress, rod, etc., and to pay per month 11·20 yen when living in the school boarding. The school has a laboratory for physics and chemistry, charts, models, diagrams and specimens for zoology, botany, geology and mineralogy and rearing rooms, reeling plant and mulberry garden for sericulture. The alumni club of students and teachers has a debating club and library, publishes magazines, carries on competitions, rearing, reeling, agriculture and sports (fencing, tennis, and other outdoor games).

Curriculum for full courses (1) and (2) :—1. Morals. 2. Language, Japanese and Chinese, reading, writing, penmanship, composition and grammar. 3. Arithmetic, algebra, *tamazan* (calculation with the abacus), geometry, trigonometry and surveying. 4. Botany, zoology and physiology. 5. Geology and mineralogy. 6. Physics, inorganic and organic chemistry. 7. Meteorology. 8. Japanese and foreign geography. 9. European, American and Japanese history. 10. Principles of law, especially laws relating to agriculture. 11. English, reading, penmanship, composition and grammar. 12. Agricultural economics, general economics, book-keeping. 13. Gymnastics and fencing. 14. Sericulture :—rearing method ; study of diseases of silkworms ; anatomy of worms and dissection ; physiology and pathology of worms ; reeling and utilising *kuzumono* (bad cocoons) ; mulberry leaf cutting ; mulberry pruning. 15. General agriculture ; vegetable growing ; fruit culture and diseases of plants ; study of soils ; manuring. 16. Animal husbandry.

Occasional experiments and practical work :—

II Year—rearing. III year—dissection of worms, handling of microscope and appliances. Practical work in mulberry and farming. IV year—Investigation of seed (eggs), rearing of worms, production of seed, cocoon drying, reeling. Practical work in mulberry cultivation, fruits and farm. V year—Testing of seed, experiments in pathology. Rearing and seed production. Cocoon drying and reeling. Testing of cocoons and silk. Practical work in mulberry fields and farm.

Curriculum for (3) short course. 1. Morals. 2. Japanese, reading and composition. 3. Arithmetic. 4. General principles of national history. 5. General principles of economics. 6. Physiology and pathology of worms. 7. Rearing and seed production. 8. Mulberry growing (for men only). 9. Reeling and utilization of bad cocoons. 10. Principles of Agriculture (for men only). 11. Experiments.

The different Sericultural Schools may vary their courses a little. As an instance, a short description of the Sericultural School at Okaya is added.

Okaya Sericultural School. The course is for five years and limited to 500 boy students.

The School year is from 1st April to 31st March, divided into three terms, *viz* :— 1st April to 31st August, 1st September to 31st December, and 1st January to 31st March.

Practical work is done even on holidays.

Candidates must be over 12 years of age and graduates of primary or higher primary school. Those without this qualification have to sit for an examination in Japanese, Arithmetic, Geography, Japanese history and Natural history. School fee 3·30 yen. Admission fee 1·00 yen.

The curriculum of this school is about the same as the full courses (1) and (2) of Annaka school given above with the omission of surveying and addition of the following, *viz.*, (1) mechanical engineering, (2) general principles of commerce, (3) cocoon drying, (4) utilization of bad cocoons, (5) designing, (6) tissue study, (7) dyeing (8) bleaching and (9) weaving.

Agricultural and other Schools. Besides these sixteen Prefectural Sericultural Schools there are 225 other schools, Agricultural and Sericultural, which teach sericulture and are equipped for the purpose.

Sericultural High Schools or Colleges. There are three Sericultural High Schools, one at Tokyo, the second at Ueda and the third at Kyoto. They are spoken of as Colleges. The prospectus of the Tokyo College is available in English and from this details about organisation and study can be seen. A brief description is added here. Their course extends to three years. These institutions provide sericultural education of the highest type and at the same time the professors and lecturers carry on research in their special subjects. The professors are almost all of them men who have either received training in foreign countries or have visited foreign countries in connection with their special lines of work. Professors, assistant professors and assistants are provided for (1) Moriculture including study of varieties of mulberry, cultivation, manures, grafting and diseases and pests of mulberry, (2) Heredity of silkworms, including study of silkworm races, (3) Rearing, (4) Reeling, (5) Chemistry dealing with mulberry, manures and silk properties, (6) Pathology dealing with diseases of silkworms due to bacteria, fungi, etc., and (7) Physiology of silkworms.

These institutions are built on extensive grounds and provided with ample buildings and laboratories and reeling and testing plants. The Ueda College is also fitted with plants for waste silk spinning, rayon making, and silk throwing. Each has extensive mulberry areas either near or at some distance.

47. Sericultural Training.

In addition to the arrangements for sericultural education detailed above training in egg-production, rearing methods, cold storage methods, cultivation and grafting methods of mulberry, drying, cooking and reeling of cocoons, and testing and handling of raw silk is given in all the experimental stations and their branches. Each keeps

about 50 to 100 probationers under training. These probationers are mostly boys and only in a few places are girls taken; for instance the Experimental Station at Ueda, where 80 girls, daughters of rearers, are trained for two years. They must have passed the compulsory primary course and either receive stipends or food and living accommodation free and in some cases some cash in addition. After training most return and work at home. Girls are mostly trained as reelers and microscopists.

The 206 Controlling Stations (*Torishi-mari Jo*) and their 137 branch stations, as will appear from the functions detailed elsewhere, also give training in mulberry, egg-production and rearing by means of the guidance which they have to exercise. These stations train the microscopists who are required to carry out examination of eggs against pebrine. This training usually extends for three months in the cold weather. The microscopist girls usually come from a better stratum of society than reeler girls and a sufficient number of them is said to come forward for training without any kind of payment.

The reeling factories train their own reelers. The period of this training extends from six months to a year and the learners are paid about 20 to 30 sen a day and food. They acquire sufficient skill during this period as they work the whole day under guidance.

In Gunze Filature, probably the best organised filature in the whole of Japan, 340 probationer girls are kept under training for reeling and are said to acquire sufficient skill in 4 months. This filature keeps 80 reelers, with 5 to 6 years' experience in reeling, under a special course of advanced training in reeling for 6 months and then engages them as head reelers to supervise the reelers. 30 to 35 boys, who are described as reeling engineers, are trained in reeling machinery for a period of one year. The qualification required is a pass through the Higher Primary course and selection is made by a competitive examination. They are given food and 10 yen per month and are also taught drawing and English. They have to sign a bond to serve the filature for two years.

Practical training in mulberry cultivation and rearing methods of the rearers themselves is arranged for through the teachers and experts employed by the various sericultural associations and co-operative societies. Whenever any new method has to be popularised. all institutions connected with sericulture including the conditioning houses arrange for giving practical training.

Last of all, the boys and girls of rearers are acquainted with mulberry growing and rearing from their childhood as they are born and grow in a sericultural atmosphere.

PART VIII. LAWS AND REGULATIONS.

48. Sericultural Law.

The Sericultural Law passed in 1911 and amended in 1917 provides for (1) control of diseases, *viz.*, flacherie (*Nan-ka-byo*), muscardine (*Ko-ka-byo*), pebrine (*Biryu-shi-byo*), grasserie (*No-byo*) and the fly pest (*Go-so-byo*) by all sericulturists, the term sericulturist including rearers of silkworms, raisers of seed (eggs), manufacturers of silk threads and floss silk and brokers and keepers of dry cocoons, silk waste and dead moths, (2) regulation of production and importation of seed (eggs), (3) regulation of sale of eggs, cocoons, and mulberry seedlings and grafts, (4) regulation of examination of silk, (5) formation of Central Raw Silk Guild and (6) granting of subsidies.

49. Regulations under the Sericultural Law.

In order to give effect to the provisions of the above Law elaborate Regulations have been formed and are in force, the main purports of which are given below under different headings. Violators of the prohibitive clauses of the Law and Regulations may be fined up to Yen 500. The Regulations specify the formation and methods of work of the following :

1. *The Imperial Sericultural Experimental Station, Nakano* and its six branches under the Minister of Forestry and Agriculture.

2. *Controlling Stations (Sangyo Torishi-mari Jo) by Prefectures.*

These Controlling Stations maintain registers of and control (1) seed producers (and also traders), (2) cocoon traders, (3) examination of original seed production, (4) examination of common seed, (5) re-examination of common seed, (6) examination of imported seed, (7) certificates and licenses issued, and (8) production of mulberry grafts and seedlings.

Eggs, egg-shells and mother moths are required to be brought and kept in the Controlling Stations for examination. The places where they are kept and where the microscopic examination is carried out and the dirty water produced in washing appliances for examination are required to be disinfected.

3. *Prefectural Experimental Stations and their branches* at the expense of the prefectural governments with the sanction of the Minister. Abolition of a station or a branch also requires the previous sanction of the Minister.

4. *Prefectural Conditioning Houses and their branches.* They can be established at the expense of the Prefectural Government on the recommendation of the Governor with the sanction of the Minister. Abolition of a conditioning house or a branch also requires the previous sanction of the Minister.

In addition to carrying out the conditioning of silk, the duties of a prefectural conditioning house include investigations relating to examination of silk and lectures, training and replying to enquiries by the public.

5. *Varieties of worms to be reared.* Varieties are specified by the experimental stations of the prefectures concerned. Rearing of varieties produced by a seed-producer may be permitted by the Governor if found to be of superior quality.

6. *Control of the parasitic fly and diseases generally.* All rearers are required to destroy the fly and its maggots and pupæ whenever found. The method of killing, either by crushing, heating or drowning the parasitic flies and their maggots and pupæ is as follows :—

(1) When crushed, their bodies are destroyed.
(2) When they are boiled, they are either to be put into boiling water or into steam of more than 212°F. or into a heat of more than 160°F. for a period of more than 10 minutes or they are to be utterly burnt.
(3) If the drowning method is adopted, the maggots are put more than 70 hours in water and the pupa more than 120 hours.

All diseased silkworms, pupæ and moths are to be destroyed by fire. Dead and flimsy cocoons are required to be dried immediately and put in boiling water and reeled off.

All rearers are required to remove diseased worms as soon as found and if there be " fear of the disease prevailing," *i.e.*, when about half the worms are suffering, rearing appliances and rooms must be disinfected.

Disinfection of rearing appliances and rooms is required to be carried out as a routine with formalin spray or gas, steam, corrosive sublimate solution and lime solution.

The method of disinfecting the rearing chambers and appliances is as follows :—

(1) *Disinfection with formalin.* The rooms are first closely shut up and even the smallest openings are closed. After this the formalin solution is sprayed, beginning from the ceiling, then the four walls and the floor. When the temperature of the room is more than 75°F., ·42 litres of 1 per cent. solution is used for 100 square feet of the interior of the room and the room kept closely shut up for 15 hours.

In rooms which cannot be shut wholly or where the temperature cannot be kept at more than 75°F., the quantity of formalin should be increased.

Disinfection of appliances should be done in a room with a temperature of more than 75° F. and using formalin solution containing more than 1 per cent. acid.

Rearing nets, mats, etc., are moistened with this solution one by one until quite wet and then they are piled up and covered carefully so as to prevent the formalin gas escaping and are left thus for more than 15 hours.

(2) *Steam disinfection.* First put the appliances in casks or boxes, steam the casks or boxes until 212°F. and keep at this temperature for more than 30 minutes ; but when the appliances to be steamed are sprayed with formalin solution containing 1 per cent. acid keep them at 140°F. for more than 20 minutes, and if this solution contains 0·5 per cent. acid for more than 30 minutes.

(3) *Disinfection by formalin gas.* The room must first be shut up closely. Keep the temperature at more than 75°F. and moisture at more than 75 per cent.

Then pile up the mats, if *Minakawa* straw mats four at a heap and if thicker 2, and nets 10 at most. Give more than 220 grammes gas when there are less than 800 trays and mats for 1,000 cubic feet of the room.

(4) *Disinfection by solution of corrosive sublimate.* Make a solution containing 0·5 per cent. corrosive sublimate and 1 per cent. hydrochloric acid, rub the ceiling, four walls and floor of the room with cloth soaked in it. Or spray the solution by using a watering can, and when the whole surfaces are quite wet, leave them untouched for more than 30 minutes.

The appliances such as nets, mats and trays are dipped in a solution of 0·2 per cent. corrosive sublimate and 1 per cent. hydrochloric acid, and then left for more than 30 minutes. Shelves are disinfected by being washed with the solution.

(5) *Disinfection by chloride of lime.* Put 5 per cent. chloride of lime in water and use the clear solution in the same manner as corrosive sublimate. The chloride of lime used should contain more than 25 per cent. chlorine.

Cocoon traders are required to adopt necessary measures for preventing escape of flies and their maggots. Unless the cocoons are stored in receptacles from which escape is impossible, the walls inside of the store house must be protected with wooden boards two feet high from the floor but if the level of the cocoons be higher the boards must be more than two inches above this level. If the floor is not tight, the ground below (the floors are wooden platforms about two feet above ground) must be cleared of maggots and pupæ by the dust or dirt being burnt or immersed in water for more than 120 hours. When transported from place to place the cocoons must be in tight boxes or bags from which escape is not possible.

Cocoons in which the worms fail to pupate and die cannot be sold unless they remain in the locality where produced.

7. *Control of pebrine disease.* Parent seed is permitted to be reared and distributed by—

(i) The Government Experimental Stations but, as they cannot meet the whole demand, also by

(ii) licensed seed-producers under the supervision of a Controlling Station staff ; and

(iii) institutions and recognised sericultural guilds specially permitted by the Minister after proper inquiry when they have three or more wholetime properly qualified experts and sufficient rearing rooms and appliances for rearing at least ten *momme* (a little more than 1¼ ounces) of newly hatched young worms and satisfy the Minister as regards their regulations for production, examination and distribution of the seed.

These institutions are not subject to the control of the Controlling Stations.

Common seed is produced and distributed by (ii) and (iii) of the above. In order to guard against unexamined eggs finding their way to be reared, persons and institutions desirous of carrying on scientific study with silkworms are required to apply to and receive permission of the Minister.

Seed-producers. The Prefectural Governor is the authority to grant license for egg-production. Those having insufficient accommodation and those with less than five years experience of sericultural work, unless a qualified expert is engaged, are not entitled to the license.

The sericultural expert must have more than five years experience of sericultural work or sufficient knowledge of the industry. The Prefectural Governor has power to change or increase the number of experts in an establishment if considered necessary. An expert cannot work in more than one establishment at the same time. The meaning of 'experience' is that the man has attended to the work continuously from the time of hatching of original eggs to that of production of common seed. Such as have taken charge of a part of the work as an employé or produced seed for their own use are not regarded as having the necessary experience. Those who have studied sericulture in theory and practice in a provincial school or training course institute or experimental station and have been granted certificates of graduation, or those who have the experience of work in a school, training course institution, producing factory or experimental station considered to be proper by the Governor and have stayed there more than one year and have been given certificates are considered to have "sufficient knowledge and experience of sericulture".

Supervision of seed-producers for production of seed. The seed-producer is to report to the Governor the dates of hatching, spinning and harvesting of cocoons and voltine character, varieties and number of cocoons expected to be reared.

He is (i) to preserve egg-shells and (ii) to keep separate under separate numbers the worms and cocoons according to voltinism, race, breed, original source of production and date of hatching and brushing.

A certificate, for which an application is necessary is issued after examination for cocoons the moths from which can be used for producing seed. Without this certificate no cocoons can be sold. If all the cocoons are parted with, the certificate is to accompany them, but, if only a part, a duplicate certificate is to be obtained and given. If the cocoons travel into the jurisdiction of a different controlling station, the original station will send the necessary information to it.

After the eggs are laid and before the examination of moths is carried out, the seed-producer has to enter necessary details on the egg card or receptacle, giving in case of varieties already existing in the country (*a*) voltinism, variety, name or marks ; (*b*) the producer's name ; (*c*) colour of cocoons ; (*d*) genealogy ; (*e*) date of laying ; (*f*) the number of moths which laid the eggs if of combined form, the number of cells if of separate cell form and the quantity of eggs if of loose form ; and in the case of imported eggs (*a*) voltinism and variety ; (*b*) name and address of the importer ; (*c*) place of origin of eggs and (*d*) colour of cocoons ; (*e*) the number of layings if of 28-frame or separate cell form, the number of moths if of combined form and the quantity of eggs if of loose form.

When examination is successful a stamp is put on the egg-paper or receptacle to show that they have been examined and passed. These stamps 'examined' and 'passed' are both necessary before the eggs can be sold or given for rearing.

If conversion of eggs from cellular, card or combined forms into loose form (*see* section 29), or changes of receptacles, are desired, previous permission with an application is necessary and all materials are required to be brought to the controlling station and fresh seals as 'examined' and 'passed' have to be put. In such cases a re-examination may be made.

When a part of an egg-paper is given to somebody else, all entries are to be entered in the part given and this must also be stamped as 'examined' and 'passed'.

Original seed can be converted and used as common seed only with permission and after cancellation of the 'original seed' stamp and imposition of a new 'common seed' stamp.

Method of Examination.—In the case of parent seed—

(1) Egg-shells are examined for pebrine.

(2) Worms (*a*) are examined as 'young' from 1st to 3rd stages and as 'grown' or 'mature' in the 4th and 5th stages.

(*b*) For each batch the number of sick, unhealthy and diseased worms is counted and their proportion determined to the whole lot in the batch. The worms are passed if the proportion be one to ten healthy ones.

(*c*) At least five worms are examined under the microscope for pebrine from each clearly distinguished variety under rearing.

(*d*) Worms are examined for uniformity of body colour in the 'young' stage and for uniformity of body type and limb (legs) colour in the mature stage.

(3) Cocoons are examined for—

(*a*) Uniformity in colour and form—the colour required being yellow, golden, green, white, bamboo-grass and pink.

(*b*) Silk content, the following average weights being required to be passed:—

(i) Univoltine of Japanese genealogy—more than 5 rin. 5 mo (about ·2 grammes).
(ii) Univoltine of Chinese genealogy—more than 5 rin. (about ·19 grammes).
(iii) Univoltine of European genealogy—7 rin. (about ·24 grammes) or more.
(iv) Bi-voltine-2nd brood—more than 4 rin. (about ·15 grammes).
(v) Fixed varieties of known genealogy—more than the average of the race from which derived.

To find out the average silk-content it is necessary to take 10 per cent. of the cocoons from a single laying and in the case of mass rearing 50 cocoons from the lot reared from one *momme* of ants, *i.e.*, 3·75 grammes of newly hatched worms.

As regards genealogy, varieties from the Caucacus and other Middle Eastern countries and Central Asia are taken as European, those from India and Eastern

Asia as Chinese and those from Korea as Japanese. Cross varieties and fixed varieties of known genealogy are called by joint names of the races from which derived, *e.g.*, Japanese-Japanese, Japanese-Chinese, etc. Fixed varieties of unknown genealogy are called Japanese, Chinese, or European, according to the type of cocoon produced.

A cross-breed is to be described as such, its voltinism indicated by that of the female and races of male and female given. The cross of pure races (or fixed ones) only are described as F_1.

(4) Mother moths are examined under the microscope, only those free from pebrine being passed. Two specimen slides are taken from each moth and examined by two examiners. After elimination of diseased layings and layings of which the mother moth is missing, a stamp, as successful original seed, is put on the egg card or receptacle. If more than ·5 per cent of the moths are found to be pebrinised, the Governor can convert the seed into common seed. Usually this is the practice.

The examinations for pebrine are carried out in the laboratories of the Controlling Stations and the other examinations at the rearing places.

The Governor, when he considers necessary, has powers of discretion to pass for original seed those in which conditions (2) (*d*) and (3) (*a*) are not satisfied.

In the case of common seed—

(i) Ten per cent. of the moths are examined and up to 1 per cent. of pebrine is passable.

(ii) When re-examination is done at the request of the seed-producer, the same method is followed. Moths are grouped into tens and the ten moths in the group examined together.

Eggs may also be examined, taking 50 to 100 from each laying of a card, these being divided into groups of 10 and each group examined.

Combined and loose forms of eggs are rejected, if containing pebrine, without re-examination.

In the case of imported seed—

(i) For permission to be reared the mother moths (if available) or eggs are examined and freedom from pebrine is necessary for use as parent seed.

(ii) For production from it of original parent seed each moth and a few of its eggs are examined, or each moth in the case of combined and loose layings, and freedom from pebrine is required for being passed.

(iii) For common seed ten per cent. of the moths are examined and up to 1 per cent. pebrine is passable.

8. *Control of production and sale of mulberry seedlings and grafts.* (*See* Part IX—Nursery men's guild.) Those engaged in the production and sale of mulberry grafts and seedlings are required to submit a report to the Governor giving the following details, *viz.*, (i) name and domicile; (ii) trade name; (iii) varieties and number of seedlings and grafts produced; (iv) area under cultivation, specifying

areas under different methods followed. They are required to have a specified signboard on their plantation. No plucking of leaves is permitted from the seedlings. Seedlings and grafts which are 'undergrown' owing to ravages of insects, fungi or other causes, or which have insects and fungi on them, cannot be sold or given to other persons except to a nursery man with the permission of the Governor. 'Undergrown' plants are seedlings less than 9½ inches and grafts less than 2 feet in growth. Plants suffering from the following are not permitted to be sold (1) *Murasaki Mompabyo*—Violet fungus; (2) *Shiro Mompabyo*—White fungus; (3) *Nekuchibyo*—Foma japanica; (4) *Kwa Kaegara Mushi*—Scale insects.

9. *Sale of Cocoons.* Persons engaged in the cocoon trade, except actual rearers, egg-producers and persons handling cocoons for their own benefit, are required to submit reports to the Governor specifying locality, duration of and approximate quantity of cocoons handled in the business, whether they themselves or their agents be in charge of it.

10. *Signboards and hawking.* All persons engaged in production of seed, silk, floss-silk and storing, drying, and selling raw cocoons are required to have a signboard on the door of their places of business. In hawking of seeds (eggs), raw, cocoon and mulberry grafts and seedlings, the hawker has to carry with him a specified license-card granted by the Governor.

11. *Supervision of dealers in Seed and Cocoons—(Regulations as in force in Saitama Prefecture).* Dealers in seed or cocoons are permitted to carry on work under a license given by the Governor on passing an examination as regards knowledge and experience of eggs and cocoons. The license is refused or may be cancelled for violation of sericultural laws and regulations, bankruptcy, immoral behaviour and punishment for criminal offence. Seed dealers cannot (*a*) sell seed in an open air stall or (*b*) sell damaged seed. Cocoon dealers cannot (*a*) engage in prospective selling without having the stock in hand unless dealing in dried or conditioned cocoons, (*b*) sell or buy cocoons before sunrise and after sunset. The dealers must have the license card with them when transacting business and produce it on demand by the police or other authorities.

License. A sericulturist, seed-producer, cocoon trader, producer of mulberry grafts and seedlings is required to report to the local Government the death of a holder of license, stoppage of business or any changes of address, etc. Failure entails a fine up to Yen 100. An heir of a licensee is entitled to the license and if he reports the death within a fortnight, he can continue the business and a license will be granted to him in due course, provided he complies with the regulations as to qualification.

12. *Formation of leagues of Sericultural Guilds and of a Central League.* The jurisdiction of a league of guilds is confined to a Prefecture. Details are specified for the formation of a Central League, election and terms of its office bearers, etc. Under these terms the Raw Silk Association of Japan has been established (*See* part IX).

13. *Subsidies.* Regulations provide that the Imperial Government will give :—

A. To the Prefectural Governments :—

1. A subsidy to the amount of (*a*) fees foregone by free examination of moths and decreased charges for examination, or (*b*) budget for prevention of diseases minus fees resulting from examination.

2. A subsidy for mulberry as much as the budget will permit (*a*) when preparation and distribution of mulberry grafts is undertaken, (*b*) when replanting of mulberry is helped, (*c*) when investigations, competitive shows and training for improvement of mulberry are undertaken, (*d*) when any investigation on mulberry is undertaken at the desire of the Minister, (*e*) when help is rendered to counties, cities or societies for the foregoing purposes.

3. A subsidy for production of parent eggs (*a*) when institutions for production of original seed are established, (*b*) when parent seed is purchased for distribution, (*c*) when a sericultural guild is helped for the foregoing purpose.

B. To the following bodies, *viz.*, (*a*) a co-operative society (*sangyo kumiai*) or a union of such societies (*sangyo kumiai rengo kai*), an agricultural society (*no kai*), a body corporate (*koeki hojin*) formed with the intention of bringing about advancement and expansion of sericultural industry, a city, a town, a village or such-like bodies, (*b*) a limited company more than 8/10ths of the shares and votes of which are in the hands of sericulturists, (*c*) a guild (*do gyo kumiai*) of sericulturists (chiefly) or a village association of sericulturists (*yo san kumiai*) or a union of such associations, a subsidy to the extent of 4/10ths of expenditure for building of a store house for cocoons on the lines suggested and recognised by the Minister or for such store-house and appliances for the improvement and development of the dry cocoon trade. Detailed rules, regulations and conditions are specified for the granting of this subsidy.

PART IX.—ASSOCIATIONS, GUILDS AND SOCIETIES.

50. GENERAL REMARKS.

Japan is a land of co-operation and associated action in all spheres of life. Universal primary education of a high order has contributed very largely to this. To take an example Saitama prefecture (*i.e.*, district) may be considered. Its area is 1,358 sq. miles and population 1,394,461 (1,050 per sq. mile) in 253,261 households in 43 towns and 325 villages. The total number of various co-operative organisations in this prefecture is 533 and there are 39 banks with 80 branches.

The associations connected with the silk industry are of three types, *viz.* :—

(1) Ordinary associations (*Kumiai* or *Kyo-Kai*) formed for some purpose under the ordinary laws of the country.

(2) Associations composed of members engaged in production, manufacture or sale of some important product with the aim of correcting defects and effecting improvements. These are called guilds here (*dogyo kumiai*). There is a special Law for Important Products Guilds (*Juyo Bussan Dogyo Kumiai Ho*) and, wherever two-thirds of the members of a particular profession agree, a guild is started and the remaining one-third members are bound to join it. This has played a very large part in removing defects and bringing about uniformity and standardization both in raw silk and silk goods to meet the requirements of foreign markets.

(3) Co-operative societies formed under the Co-operative Societies Law.

The main provisions of the Law of Staple Products Guilds and regulations under it are given below and also a general description of co-operative societies, before giving information about the sericultural associations, guilds and societies themselves.

51. LAW OF STAPLE PRODUCTS GUILDS (*Juyo Bussan Dogyo Kumiai Ho*).

(Law No. 15 of 5th year of Taisho, 1916.)

Those who are engaged in producing or manufacturing important staple products (Juyo-Bussan) or are engaged in the trade of these products can organise a (Dogyo Kumiai) guild among themselves or with those who are engaged in businesses which have a special close connection with these products. Staple products and things allied to them are declared as such by the Minister of Forestry and Agriculture.

Objects. The objects of the guilds are removal of defects and promotion of profits of those engaged in the profession co-operatively.

Organisation of a (Dogyo Kumiai) *guild.* A guild is organised when two-thirds of the people engaged in the business agree. When a guild embracing two or more different professions is to be organised the consent of two-thirds of the members of each profession is necessary. Similarly dissolution also requires the consent of two-thirds of the members.

Those who are engaged in the same profession must join the guild. The Minister can grant an exception if he deems it necessary.

To promote mutual benefit and to attain their aims guilds can form themselves into a League (*Dogyo Kumiai Rengokai*). They should have the following office-bearers, *viz.*, President one, Vice-Presidents several and several committee members. Besides, they may have other officers according to regulations.

They can make provisions in their statutes for examination or inspection of the products of the members and against violation of the regulations and can levy compensation for losses owing to such violation or confiscate the things which cause violation. They must have examiners for carrying out this inspection.

The Minister of Agriculture and Forestry has complete control over the guilds. He specifies what is to be considered as staple export product, sanctions formation as well as dissolution of a guild or league of guilds, can cause a guild or league of guilds to be organised, can alter their jurisdiction, method of work, decision, budget, method of collecting funds and statutes, can order a guild to join a league, approves of the appointment and dismissal of examiners as well as office-bearers, can punish office-bearers and examiners for any action against the Law or against the interests of the guild or league of guilds and can demand reports and investigate the affairs of a guild or league of guilds.

Provision is made for punishment with fine up to Yen 500 of those who do not join a guild when formed, of office-bearers and examiners if they refuse to work or hinder work, of a guild for not joining a league, of those who counterfeit trade marks and certificates and of those who receive or offer bribes.

52. REGULATIONS UNDER THE LAW OF STAPLE PRODUCTS GUILD

require that only a *Do-gyo Kumiai* can use this word in its name and that the jurisdiction of a guild except in special cases cannot be larger than a Prefecture but must be larger than a city or county. Detailed instructions are given as to how a guild or league of guilds is to be initiated and formed as well as how it is to be dissolved, how office bearers are to be elected, how voting is to be done (votes are equal in all cases), how meetings are to be conducted and records kept and how arbitration, if decided upon, is to be carried out. Alteration of any rule requires the consent of two-thirds of members in the case of a guild and of two-thirds of representatives in the case of a league. The supervisory powers of the Minister are delegated to the Governor of the Prefecture.

53. Co-operative Societies (*Sangyo Kumiai*).

In the development of sericulture the co-operative movement has played a very great part. The number of co-operative societies in 1927 was 14,186 or approximately 1·2 societies to each of the cities, towns and villages in Japan and one for each community. About 74 per cent. of the members of all the societies are agriculturists who are the persons mainly concerned with sericulture. Each society had on the average 298 members.

According to the Law co-operative societies are established for the following purposes with the aim of economic improvement of the people :—

1. Lending money to the members for financing industry and offering facility for saving by receiving deposits. (Credit societies—*Shinyo Kumiai.*) Interest charged on loans is 9 or 10 per cent., which is lower than the current local rate which is usually 12 per cent. Interest allowed on deposits is 6 to 7 per cent.

2. Selling articles produced by the members with or without further modification (*Sale societies—Hanbai Kumiai*). Sales include cocoons, raw-silk, textile fabrics, seeds, seedlings and silkworm eggs.

3. Purchasing necessary goods and articles for industrial use and selling them to the members with or without modifications or selling to the members articles produced by the societies (*Purchase societies—Kobai Kumiai*). Purchases include fertilizers, agricultural implements, seeds, seedlings and silk-worm eggs.

A form of such societies called consumers' co-operative societies has grown up among wage earners and salaried men.

4. Procuring, and letting the members utilise, installations, appliances, etc. for industrial production. (*Utilization societies—Riyo Kumiai.*)

The equipments of these societies include threshing, rice cleaning, milling, manure-crushing, rope and mat making, irrigation, drainage and barley-preparing machines, market for agricultural products, live-stock, land for agriculture, forestry and stock-breeding, water-mills, silk-mills, implements for sericulture, agriculture and paper-making, carts, boats, irrigation ponds, store-houses, textile apparatus, petroleum, motors, current distribution, offices and power stations, public baths, barbers' shops, hospitals, kindergartens and implements and clothes for weddings and funerals. In 1925 each of 2,038 societies operating realised 1922 yen as rent on the average.

Liability of members is of three kinds, *viz.*—

1. Limited liability to the extent of the share held.

2. Unlimited liability in which the members are jointly and severally liable for the whole of the debts of the society.

3. Guaranteed liability up to a certain specified amount beyond the shares held.

In 1926 about 87 per cent. of the societies were with limited liability.

As regards a federation or union of co-operative societies the liability is restricted to limited and guaranteed types.

Storage of cocoons. A special law provides that in warehouses for storing agricultural produce nothing can be stored along with cocoons likely to damage cocoons and these warehouses must be in the hands of co-operative societies, agricultural societies or institutions of public utility.

Federations. Some of the federations of raw silk selling societies are very large and as a pinnacle the Japanese Raw Silk Selling Co-operative Federation, established in 1927, includes practically all co-operative reeling factories.

The Central Union of Co-operative Societies in Japan (*Sangyo Kumiai chuokai*), operating since 1905 and recognised by law since 1910, is formed by co-operative societies, federations of co-operative societies and individuals interested in the co-operative movement. It is under the direct supervision of the Ministries of Agriculture and Commerce and is for practical purposes a semi-official organisation. It has a branch in each prefecture. Its functions are :—

1. Organisation and development of co-operative societies and federations of co-operative societies and maintaining close relations between all.
2. Education in co-operation by organising classes and lectures on account-keeping and management, summer classes for primary school teachers when the schools are closed and general lectures for the public.
3. Investigation and publication ; it publishes a bulletin called " Co-operation " and a popular magazine called the " Home-Light " every month.
4. Investigation into the condition and revision of societies and federations.
5. Popular propaganda by means of congresses, conferences, films, posters, musical records, etc.

54. Organisations connected with the raw silk industry.

The following three embrace the whole country.

I. The Silk Association of Japan (*Dai Nihon San Shi Kai*). This is the English name under which it is described. " Sericultural Association of Japan " would probably be a better name as it deals with sericultural operations practically wholly. It is an association of the first type.

II. The Raw Silk Association of Japan (*Sanshigyo Dogyo Kumiai Chuokai*). This is its English name in Japan. " Central Raw Silk Guild " would probably be a name to describe it correctly as it is a guild according to the classification adopted here, formed under the Sericultural Law according to the provisions of the Important Products Guild Law.

III. The Japanese Raw Silk Co-operative Federation (*Dai Nippon Kiito Hanbai Kumiai Rengokai*). It is a co-operative sale society for raw silk produced by the co-operative filatures, started in 1927 under the Co-operative Laws, with its head-quarters at Yokohama.

As a new co-operative move, a new Silk Manufacturer's Union Law has been passed in 1931 providing that this Union is to be a juridical body and divided into groups of (1) Sericulturists, (2) Silk-worm Rearers, (3) Filatures, (4) Industrial Unions,

(5) Raw Silk Manufacturers, (6) Raw Silk Wholesale Dealers and (7) Raw Silk Exporters and that a Central Sericulture and Raw Silk Association is to be organised to include all Unions in the country.

The following are confined to a prefecture and those mentioned below were found to exist in the Saitama prefecture. The number of rearers in this prefecture is 1,01,209 with about 76,000 acres of mulberry, that of mulberry nursery-men 2,696, that of seed producers 343, that of cocoon traders 6,041, that of seed (egg) traders 1,258 and that of sericultural teachers or experts 1,753. The rearers' associations are the only ones to be confined to villages. The various organisations are shown below according to their jurisdiction.

Prefecture		County	Village
1. Federation (*Rengo Kyo Kai*).	A. Mulberry nursery-men's guild (*Sobyo or Kwanai Dogyo Kumiai*).*	A. Branch.	
	B. Egg producers' guild (*Sanshu Dogyo Kumiai*).	B. Branch.	
	C. Seed-traders' guild (*Sanshu Hanbai Dogyo Kumiai*).	C. Branch.	
	D. League of Unions of Rearers' Associations in the prefecture.	D. Union of Rearers' Associations in the county.	D. Rearers' Associations or union of such associations when more than one in a village.†
	E. Cocoon and raw silk traders' guild (*Kenshi Dogyo Kumiai*).	E. Branch.	
	F. Sericultural Teachers' Association (*Yeosan Gijitsu Kyokai*).	F. Branch.	
2. Filatures guild (*Seishi Dogyo Kumiai*).			
3. Prefectural Union of Co-operative Silk Sale Societies (*Saitama sha*).			
4. Branch of the Silk Association of Japan (*Dai Nihon San-shi Kai*).			
5. An association or rather a periodical meeting to discuss sericultural matters (*San Ken Kyo Kai*). (This is recently formed.)		G. Co-operative cocoon drying, storing and sale society.	

* Nursery-men's organisations in other prefectures are said to be of co-operative type.

† Rearers' associations, although not formed according to co-operative or guild laws, are based on co-operation and for all practical purposes are co-operative societies.

Besides the above, there is a co-operative cold storage society (*San Shu Rejo Kumiai*) at the headquarters of the Saitama prefecture. It is a small local organisation.

55. Description of the Associations, Guilds and Societies connected with the Raw Silk Industry.

A short description of the aim, work, and organisation of one of each type visited in the Saitama prefecture is given here. All have printed rules and regulations and even village associations publish annual reports. The numbers, etc., given below to the different organisations are according to the statement in the previous Section.

I. *The Silk Association of Japan.*

This association with its headquarters in Tokyo was established in 1892 with the aim of improving the sericultural industry. It has a patron belonging to the Royal Family. Membership is of two classes, *viz.*, (1) Special, who contribute 50 yen or more at a time. The number of such members is at present 10,452, (2) Ordinary, who contribute 3 yen at a time. The number of ordinary members is at present 257,372.

The special members elect a body of 25 trustees for three years. The trustees elect for three years, (1) a managing committee with a President, two Vice-presidents and five members, (2) two financial advisers and (3) three committees, *viz.*, (*a*) Technical Committee, (*b*) Publication Committee, and (*c*) Extension, encouragement and subsidy committee. In addition to the above, advisers may also be elected.

The paid staff consists of one Superintendent and several clerks, experts and assistant experts.

Branches. The association has at present 44 branches, one in each of 44 prefectures, the whole prefecture being its jurisdiction. The Governor of the prefecture is elected as President of a branch by the Patron. There are one to three Vice-presidents, one secretary and several assistant secretaries and several clerks. An advisory committee is elected from among the members for three years. A branch may have its own funds and property, movable and immovable. The work of a branch consists in :—

(1) Enrolling new members and expanding the activities of the association, (2) maintaining a register of members with their addresses, (3) spreading the publications of the association, (4) securing contributions, (5) guiding and directing people engaged in sericulture, (6) preparing statistics and carrying out necessary investigations, (7) holding exhibitions, competitions, lectures, etc.

Funds. The accumulated funds at present amount to 59,320,592 yen.

The income is derived from subscriptions, donations, contributions for special purposes, interest of accumulated funds and results of association's activities.

In 1918 Government gave a grant of 20,000 yen for subsidising rearers' associations and its interest is utilised for the purpose.

When a branch secures a new member or contributions for the association half the amount is allotted to the branch. Contributions for any special purpose named by the donor are not divided in this manner.

The publications issued are (*a*) a report every month giving statistics of the sericultural industry, (*b*) a monthly magazine called the "Light of Sericulture", containing popular articles for the common rearers.

II. The Raw-Silk Association of Japan.

This Central Raw-silk Guild with its headquarters at Tokyo was started on 1st October 1915. The aim is (1) to remedy defects in the raw-silk industry, (2) to investigate and find out methods which will help removal of defects and adopt such methods, (3) to get the law and regulations changed when necessary and educate the public about them, (4) to advise the Minister on improvements, (5) to investigate the raw-silk industry at home and abroad and collect and publish statistics about it, (6) to increase the sale of sericultural products in foreign countries, (7) to keep in touch and maintain friendly relations with kindred organisations in foreign countries, (8) to guide and improve the sericultural guilds in the country, (9) to arbitrate in cases of dispute, and (10) to carry out measures necessary for the improvement of the raw-silk industry.

This association embraces the whole country and includes as its constituents all kinds of organisations connected with egg-production, rearing, cocoons, reeling and the trade in raw silk. One hundred and thirty representatives are elected from these various organisations according to a fixed schedule of allocation and these in a general meeting elect for three years a committee consisting of a President, not more than three Vice-presidents and 30 members, all of whom are eligible for re-election. The committee is honorary but actual expenses for performance of the duties are paid and also honoraria if decided in a general meeting.

There is also an advisory board of 216 members elected according to a fixed schedule. No one can serve both as a representative and as a member of this board.

Advisers, consulting experts and committees of experts may be appointed for particular purposes.

There is a paid staff of manager, assistant manager and clerks.

Funds. The association started with a capital fund of 500,000 yen contributed especially for it and has thus a permanent source of income. The annual expenditure in excess of this income is levied at a fixed rate from various organisations, *viz.*, 15 per cent. from seed producers, 55 per cent. from filatures and 30 per cent. from other organisations connected with the raw-silk industry.

Grants and contributions for special purposes are also received. Thus, the Imperial Government gives an annual grant of 13,000 yen for the purpose of bringing about an agreed method of raw-silk classification.

Recently a scheme of propaganda in the United States of America, the principal market of Japan's raw silk, has been proposed to be adopted and endorsed by the Silk Association of America according to which a cess of 1 yen on each bale of raw silk exported to the United States of America will be levied and the proceeds, expected to amount to about 1,000,000 yen will be handed over to this association to organise such propaganda.

A. MULBERRY NURSERY-MEN'S GUILD. (*See* SECTION 49, SUB-SECTION 8.) (*Sobyo dogyo Kumiai.*)

The aim is to improve mulberry and its cultivation, regulate sale and take measures against diseases and pests.

Its jurisdiction extends over the whole prefecture with a branch in each of its 9 counties. All nursery-men, growers, buyers and sellers, must be members. There are 24 inspectors.

The nine county branches elect representatives according to a specified number and the representatives in a general meeting decide the budget, rate of subscriptions, rules regarding inspection and sale of plants, prices, election of office bearers and all other matters concerning the guild.

Honorary office bearers elected for two years with the right of re-election are the President, two Vice-presidents, and a committee consisting of 13 elected members and 9 heads of the nine branches. They may be given an honorarium if so decided in a general meeting of the representatives.

Paid officers are inspectors, experts, and clerks. The appointment of inspectors is subject to the approval of the Director of the prefectural Experiment Station. Inspectors are practical farmers, trained in the Experiment Stations and recognised by the Governor of the prefecture.

The committee can elect honorary advisers.

Rules regarding inspection apply to those who make nurseries for selling mulberry grafts and plants which must be inspected and stamped before sale.

1. Inspection regarding passable and unpassable grafts and plants—

I. Grafts, passable—

(*a*) *Grand extra.* (i) length over 5 feet or circumference at base over 1¾ inches; (2) hardness of stem highest; (3) root growth very good; (4) no injury and no dry part; (5) protection of roots complete with earth or wet covering; (6) no disease and no insect damage.

(*b*) *First class.* (1) length over 3 feet or circumference of base 1⅛ inches; (2) hardness high; (3) roots good; (4) no injury and no dry part; (5) as above; (6) as above.

(*c*) *Second class.* (1) length over 2 feet; (2) hardness common; (3) root-growth common; (4-6) as above.

(*d*) *Third class.* (1) length over 2 feet ; (2) hardness low ; (3) roots not good ; (4) injury and dry parts present ; (5) root protection not complete and formation bad ; (6) somewhat damaged by disease and insects.

II. Seedlings, passable—

(*a*) *Grand extra.* (1) Grafting part, *i.e.*, the upper part of the root over $1\frac{1}{5}$ inches or circumference of the base of the stem over $\frac{7}{8}$ inch, (2) hardness highest,, (3) root growth very good, (4) no injury while being dug out, (5) protection of roots complete, (6) no disease and no insect damage.

(*b*) *First class.* (1) Circumference of root over $\frac{7}{8}$ inch or of stem base over $\frac{5}{8}$ inch, (2) hardness high, (3) root growth good, (4) no injury, (5) protection complete, (6) no disease and no insect damage.

(*c*) *Second class.* (1) Circumference of root over $\frac{1}{2}$ inch or stem base over $\frac{3}{8}$ inch, (2) hardness common, (3) root growth common (4-6), as above.

Not passable.—(1) growth bad, circumference of root less than $\frac{1}{2}$ inch or of stem less than $\frac{3}{8}$ inch, (2) hardness low, (3) root growth bad, (4) injury present, (5) root protection incomplete and formation bad, (6) disease and insect damage present.

III. Original plants for layering to be passed—

(1) root growth good, (2) no injury, (3) no disease and no insect damage.

2. *Making up bundles.*—Grafts 50 and seedlings 50 to 100 to be tied with rope just above the middle part, the rope to be taken twice round the bundle and then knotted leaving two and a half inch lengths of the two ends which are to be wrapped in paper and to have the pass label attached (the pass label is a printed label with descriptions and the inspector's stamp).

3. Packing for distant places—

	Pyramidal form.	Cylindrical form.
Grafts—		
Grand extra	400	500
First class	600	800
Second class	800	1,000
Seedlings—		
Grand extra	3,000	5,000
First class	5,000	7,000
Second class	8,000	10,000
Original plants for layering	...	11,000

Packing should be in straw with ropes at two places and tops may be lopped when desired by the purchasers.

County branches.—Kawagwe county branch of the Mulberry Nursery-men's Guild has jurisdiction over the whole county which for convenience is divided into 11 circles. The total number of members is 250. The honorary office-bearers are

a President, three Vice-Presidents and eleven heads of the circles whose term is two years and who may be given honoraria if decided in a general meeting of the members. There is a paid clerk. Advisers can be appointed by a decision of the general meeting. The expenses are met by subscription from members and contribution from prefectural guild. The members pay no admission fee but an annual subscription of 2 yen of which 0·50 yen goes to the main prefectural guild.

In Kodama county branch of the Nursery-men's Guild, there are 1,200 members and 8 inspectors. The inspectors work about 3 to 4 months from December and are paid Yen 100 in all. No travelling allowance is paid, the inspectors using their own bicycles.*

Each member pays an admission fee of 1 yen and an annual subscription of Yen 1·50 of which 1 yen goes to the main prefectural guild. Inspection charge in this county is 1½ sen for a bundle of 100 plants. There is one clerk and the office is located in the local controlling station.

B. Egg-producer's Guild. (*Sanshu Dogyo Kumiai.*)

It has eight branches covering the prefecture. The aim is production of improved seed through improved races and methods. Members have to pay for expenses and share assets and liabilities. The honorary committee is made up of president, two vice-presidents, 8 members, and 8 branch presidents elected for three years. Specialists and clerks are paid.

Special rules may be made by the committee for examination for prevention of diseases, especially pebrine, and non-compliance with these rules entails fines. The existing rules enforce forced emergence of moths from seed cocoons by incubation, and if more than 3 per cent. pebrine is found the lot has to be rejected.

The Kawagwe County branch of the egg-producer's guild has 120 members who pay 40 yen each per year. It arranges for :—

1. Improvement of working methods of the members by employing experts who are paid at Yen 60 per month and actual travelling expenses.
2. Cold storage of eggs in the cold store of the local controlling station.
3. Examination of 50 to 100 eggs from each laying of the egg card, this examination being carried out in the local controlling station at a charge of 2 sen 8 rin per card.
4. Examination of the moths whose emergence is forced by incubation, the forced emergence and examination of the moths being carried out in the local controlling station from two boxes of each variety containing 120 seed cocoons each, at a charge of 20 sen per box.

C. SEED (EGG) TRADER'S GUILD. (*Sanshu Hanbai Dogyo Kumiai*).

The aim is to study both production and market and bring about large sales. Election of a committee is on usual lines.

* Bicycles are in extensive use in Japan. Farmers, men, women, boys and girls on bicycles are a common sight in the villages.

Each member has to submit a statement of the quantity of seed dealt with by him before 15th March. No member can deal in varieties of worms not specified by the guild and also in eggs which will hatch the same year (owing to chemical treatment or bivoltinism) if such eggs have been kept in cold store for more than 30 days. Minimum and maximum prices of eggs are fixed by the guild but are not binding.

The Kawagwe County branch of Seed Trader's Guild has 200 members who pay no admission fee but an annual subscription of 2·50 yen of which 1 yen goes to the main guild.

Each member is examined by the authorities of the prefectural experimental station on his knowledge, both theoretical and practical, as regards treatment of eggs when in his charge or in cold store and also as regards disease and given a license free of charge.

D. Rearers' Associations.

The rearers' afsociations, if more than one in a village form themselves into a village union. Each association pays nothing to the village union but 15 yen annually to the county union. The union fixes standard wages for employees and labourers engaged by rearers.

The association visited at Harigane village with 35 members engages an expert whose duties are to incubate the eggs and distribute them to the members, guide rearing and mulberry cultivation, look after the common mulberry of the association, give technical help in the sale of cocoons and collate results for preparation of reports which are usually published.

The association arranges for purchase of eggs and manures and sale of cocoons cooperatively, maintains a common mulberry plantation about three-fourths acre in area by free labour of the members as demonstration in cultivation and as a source of leaf supply at less than current cost in case of necessity, makes members effect savings compulsorily, the amount saved up to 1927 being 10,660 yen, renders monetary help to members at less than current rates of interest, an advance up to 200 yen being made which is repayable on the sale of cocoons, awards prizes and rewards to employees and labourers who work well and stay with the same master for three years or more, holds competitions among members in rearing and mulberry growing and arranges for weather signals so that members may be warned before-hand to be ready for making fires in case of frost.

Members are required to pay an admission fee of 20 yen, an annual subscription of 6 yen and a contribution calculated at 15 sen per egg card hatched and 10 sen per *Kan* of cocoons harvested. With donations from the county league, village agricultural associations and other private sources and by curtailment of unnecessary expenditure a reserve fund has been built up since 1915 and its amount in 1927 was 4,100 yen.

County unions of rearers' associations.

All existing and new associations are made to join the union, pay its expenses and act according to rules formed by it. Withdrawal is allowed on permission and on sufficient grounds. Non-compliance with rules may cause expulsion and forfeiture of share of assets of the union. The union itself can be dissolved on a vote of more than four-fifths of the component associations.

There is a committee of honorary office bearers. Paid officers are one clerk and several supervisers and workers who are controlled and employed or dismissed by the president. There are several advisers and patrons who can be present in a general meeting.

For facility of work the whole county is divided into eight sub-leagues or sub-unions (*Shi-kai*).

Income is derived from contributions at (*a*) 6 per cent. of the income of each association and (*b*) 4 per cent. of sale proceeds of each member of all associations.

The work of the union consists in : (1) encouragement and improvement of mulberry plantations ; (2) maintenance of model plantations and nurseries and encouragement of such work ; (3) encouragement of separate plantations for spring, and summer as well as for young worms ; (4) standardisation of mulberry varieities ; (5) improvements in rearing methods ; (6) encouragement of employment of experts and selection of such experts ; (7) co-operative storage of seed ; (8) encouragement of co-operative hatching of eggs and rearing of young worms ; (9) encouragement of co-operative drying and sale of cocoons ; (10) co-operative purchase of mulberry grafts and seedlings and appliances ; (11) improvement of existing rearing houses and encouragement for building new ones ; (12) Investigation into the economics of sericulture ; (13) having training courses and lectures on sericulture ; (14) holding competitive exhibitions of sericulture and encouragement of such exhibitions ; (15) investigation with a view to improvements in all aspects of sericulture ; (16) publication of reports, statistics, etc.

Prefectural league of unions of rearers' associations.

The prefectural league of the Saitama prefecture is a league of the unions of the nine counties of the prefecture with its headquarters in the prefectural Experiment Station at Kumagaya. The county unions elect for three years 59 representatives, the number of representatives of individual unions varying from 3 to 13. Funds are contributed by the component unions.

Honorary office bearers of the committee of management consisting of president, two vice-presidents and nine members are elected from among the representatives. A superintendent and several clerks are paid officers and are under the control of the president. The committee can elect advisers and patrons from outsiders.

The work of the league consists in—

(1) Investigation of measures for the improvement of the industry and helping adoption of such measures.

(2) Guiding the component county unions.

E. COCOON AND RAW-SILK TRADERS' GUILD.

(Ken shi Dogyo Kumiai.)

The guild has jurisdiction over the whole prefecture and one branch in each of the nine counties.

It aims at improvement by—

I. Not doing the following, *viz.* : (*a*) mixing together cocoons produced in different seasons ; (*b*) mixing in one lot different varieties of thread, thick and thin threads and threads of good and bad quality ; (*c*) mixing double cocoons with good cocoons in reeling ; (*d*) mixing dirt, wastes, etc., in order to increase weight of thread. Violation may lead to suspension of business or punishment by law.

II. Adopting the following measures, *viz.*: (*a*) honouring patrons and benefactors; (*b*) competitions and shows ; (*c*) sending investigators to other parts of the country or to other countries and circulating the results of their investigation to members ; (*d*) supervising the employees ; (*e*) encouraging employees with certificates of merit, prizes, and monetary help ; (*f*) arbitration of disputes ; (*g*) joining other cognate organisations in a league or union ; (*h*) carrying out other important relevant matters.

Membership extends to the following persons who must join, *viz.*,—

(1) persons engaged in raw-silk trade,
(2) those working as agents of such work,
(3) those engaged in buying and selling of thread from inferior and double cocoons and in inferior waste.

Each member has a badge which must be worn on the left breast when transacting business, cannot be lent or given away and when lost must be replaced by a fresh badge at the applicant's expense. The badge must be returned on cessation of work, at death, stoppage and transfer of business to others, or departure from the jurisdiction.

The honorary committee of management is elected for three years.

There are one paid manager and clerks who work under the president.

Each branch has an elected committee.

The Kawagwe county branch of this guild has 1,300 members who pay no admission fee but an annual subscription of 3 yen out of which 0·50 yen goes to the main guild.

F. Sericultural teachers or experts association.

(*Gijitsu Kyo Kai.*)

This association is formed by persons engaged in teaching sericultural methods, *i.e.*, experts within the prefecture employed by associations, societies and guilds and has seven branches comprising the whole prefecture.

The branches elect their own committee and also representatives to the main association at the rate of 1 representative for every 10 members. The representatives elect a committee for the main association consisting of president, 2 vice-presidents, several members and the 7 branch presidents. All office bearers are honorary and elected for two years. Clerks are paid. There may be honorary advisers.

The aim is to improve sericulture. Meetings and lectures are held and the work is described as (1) research into methods of sericulture and adoption of improved ones, (2) guidance of sericultural work, (3) submitting suggestions to authorities.

As regards finance the branches levy an admission fee of 1 yen from members and pay it to the main association.

In the Kawagwe county branch no admission fee is charged for the branch itself but members pay an annual subscription of 3 yen of which 80 sen is paid to the main association which is entitled to levy a contribution from the branches to the extent of actual deficit. The main association keeps the income from admission fees as a reserve. Some income is derived from fees for issuing certificates.

2. Filatures guild.

(*Seishi Dogyo Kumiai.*)

The guild has jurisdiction over the whole prefecture and aims at: (1) devising of measures to improve and unify cocoon qualities; (2) researches in reeling; (3) training and protection of workers and unifying rules of work; (4) providing training and lecturers and holding competitions; (5) rewarding and honouring members and employees who benefit the industry by invention, etc.; (6) employing experts to carry out (1) and (2); (7) bringing important matters to the notice of the Government; (8) answering queries of government with regard to reeling; (9) carrying out other relevant matters decided upon in a general meeting.

The component filatures have to report the number of basins and re-reeling reels before 5th July and also changes in this number. They meet the expenses and have the following votes in a general meeting, *viz.*, 1 for each 100 basins, 2 for 100 to 300 basins, 3 for 300 to 500 basins, 4 for 500 to 700 basins and 5 for more than 701 basins.

Honorary office bearers are elected for three years to form a committee. The paid officers are one manager and several clerks. There may be honorary advisers and a special committee when dealing with other associations.

3. *SAITAMA SHA* ; UNION OF CO-OPERATIVE SILK SALE SOCIETIES IN SAITAMA PREFECTURE.

A description of this co-operative organisation has been given in Section 10, Part II under Organisations for reeling.

It is a society with limited liability and its aim is described in the rules and regulations as (1) selling goods of the component societies and (2) letting component societies make use of plants and appliances. Co-operative societies selling silk or both selling silk and carrying on other work and having their headquarters in the Saitama prefecture can join and they cannot join any other union.

Organisation. Each component society sends a representative and the representatives in a general meeting elect for three years a committee of 7 members (*rijis*).

There is a board of 15 trustees (*Kyogi-in*) elected for 3 years from among the elected office-bearers of the component societies.

There is an adviser elected in general meeting. All the above are honorary but can be given honoraria and actual expenses incurred in connection with society's work.

There are paid clerks, experts and assistant experts.

Finance. A component society pays 3 yen with application for admission.

The share to be subscribed is 500 yen of which the first instalment of 50 yen has to be paid before registration. Amounts and dates of payment of later instalments are fixed and delay in payment involves an interest of 1 per cent. per day.

There are three reserve funds. The first reserve must be double of the total shares and built up by contribution of one-fourth of the yearly profit in addition to admission fees, fines and unpaid claims. The second reserve is built up with donations and subsidies. There is a third reserve to meet losses, by contribution of one-thirtieth of the cost of plants and appliances.

After meeting the above a dividend up to 6 per cent. is paid.

One-half of paid up shares is paid back on withdrawal which takes effect after one year of notice and eight-tenths on expulsion due to non-payment of dues for more than three months and independent sale of silk and insolvency.

Work. The society deals in silk thread. The component societies are not to undertake independent sale. The silk is sorted out into filature and *Zaguri* and sold

under the society's mark. Inferior silk is sold without the mark. The component societies may be given an advance price on their silk at a daily interest of 3 sen per 100 yen.

G. Co-operative cocoon drying, storing and sale society (*Kan Ken Kumiai*) of Osato County.

This society of limited liability has been referred to in Section 6. Its formation in 1925 was due to the regulations passed by the Imperial Government to give 40 per cent. of the expenses for plant and store house in order to encourage trade in dried cocoons

It has an up to date warehouse for cocoons, three drying plants at headquarters and one drying plant at each of three other receiving stations.

Production of good cocoons and uniform cocoons is encouraged by granting monetary help to members when they engage the services of the society's experts, when eggs specified by the society are used and when in any particular locality more than 70 per cent. of the cocoons produced and submitted by the members in a year are of a specified variety.

Up to 70 per cent. of the current price of cocoons may be advanced to the members on their cocoons received by the society and an interest up to 3 sen a day on every 100 yen may be charged, *i.e.*, about 10 per cent. per annum.

Organisation. 5,091 sericulturists took 11,278 shares at 10 yen each and Government contributed 74,599 yen. The society permits formation of branches when there are at least 30 members (and in special cases less) living in the same locality. It has 131 branches in 27 towns and villages in the county. The work of a branch is (1) to requisition and utilise the services of sericultural experts, (2) to collect and forward the cocoons of the members to one of the four receiving centres of the society and to receive and distribute the sale proceeds to the members, (3) to arrange for co-operative buying of seed for the members and (4) introduce improvements in methods, etc. Fees have to be paid for the services of experts but a subvention is given for the purpose.

Financial. A reserve fund equal to the capital is required to be built up by contribution of one-fourth of the profits every year. A dividend up to 6 per cent. is allowed. A special reserve is built with surplus profits. A sinking fund is required to be built up equal to the amount received from the state or any outside body for purchase, repair or improvement of equipment. There is also a bonus fund for employees. Surplus if any after contributions to the above is carried to the next year.

On withdrawal for which notice of a complete financial year is required, a member receives back 7/10 of his paid up shares. On death, if the heir does not like to con-

tinue, or on forfeiture of membership due to decision of representatives in a meeting, the whole of the paid up shares is refunded. Only one-fourth of paid up shares is refunded on expulsion for failure to pay dues, for passing others' cocoons to the society as one's own, for bankruptcy, for letting others use the property of the society, and for acting in a way which interferes with the working of the society.

Co-operative Cold Storage Society at Kumagaya in Saitama Prefecture.

This society has a cold store of masonry with 5 chambers 5′ × 5′ each. This is enclosed by a wooden structure with double walls having 8″ of sawdust inside. The space about 8′ between the chamber and the outer structure is filled with 100 tons of ice in January which lasts till September. The store was built at a cost of Yen 4,000 and the annual recurring cost for ice, etc. is 900 yen. Fifty thousand egg-cards are stored at a charge of 3 sen per card giving a return of 1,500 yen per year.

PART X.—THE SILK-MANUFACTURING INDUSTRY.

56. General remarks.

Japanese silk goods are well known in every country. Their export started about 1849, a little before the opening of the port of Yokohama to foreign trade, and their present value about 1928-29 was near about yen 200,000,000. At first the export trade of these goods was located at Yokohama in the hands of foreigners. Japanese firms took to it about 1875. After the earthquake disaster in 1923, the trade was diverted to Kobe which at present carries on about two-thirds of the total business. The methods followed in developing this export trade are of interest. Weaving is an ancient art in Japan, formerly, as everywhere else, carried on with domestic hand looms as a cottage industry. Generally speaking, this domestic foundation of the industry has been maintained and built upon, the domestic hand looms being replaced by improved power looms, *i.e.*, looms worked with electricity. Cheap Jacquard looms, built with wood and iron parts where necessary, are used everywhere and cheap electricity is available in the remote villages. Looms are also worked on factory lines on a small or large scale.

The raw materials used in weaving are raw silk and spun silk produced in Japan and *Tasar* silk imported from China.

Rayon or artificial silk is woven on the same looms by the same weavers. Weaving in large mills is carried on only for certain classes of materials and is small compared with domestic weaving.

Rayon production and weaving have developed at a rapid rate and the consumption of rayon yarn now is more than twice the quantity of silk yarn. In 1929 rayon was being woven everywhere on a larger scale than silk. India, China and the Far Eastern countries are the main markets for Japan's rayon products.

The secret of Japan's success in foreign markets is (*a*) close and continued study of the requirements of these markets by special representatives either stationed permanently in these markets or sent out every year and (*b*) standardisation. Production of uniform standardised high class materials has been the result of strenuous efforts on the part of both Government and the people in setting up technical institutes both for training and research in all important weaving districts, in taking measures for the adoption of improved methods and processes wherever found in other countries, in unifying boiling, washing, finishing and calendering processes where desired and possible, and, last of all, in compelling by law submission of all export goods to a strict inspection in order to maintain their standard and reputation in foreign markets.

57. Inspection or conditioning of export goods.

Inspection of export goods is said to have been prevalent even in the early days of export from Yokohama where the Ten Mens' Association carried out this inspection. Until lately various weaver's guilds and associations carried out inspection which has now been taken over by Government. There are Government cloth conditioning or inspection houses for export goods at twelve places, at Kyoto, Yokohama, Kobe, Kiriyu, Ashikaga, Nagoya, Gifu, Fukushima, Tsuruoka, Fukui, Kanazawa and Toyama. In 1928 these houses inspected 3,315,604 pieces of which 87,547 were rejected.

58. Laws and regulations for export goods. The Law for the control of silk manufactures for export. (Law No. 27 of 30th March 1927.)

(1) No export silk is allowed to be exported for business purpose, unless it has passed the inspection made by the Imperial Japanese Government Silk Inspection Office, in accordance with the provisions of Ordinances. This does not apply, however, to a fabric, for which permission has previously been given by the Minister of Commerce and Industry under special circumstances. (2) In order to maintain or raise the reputation of export silk fabrics, the Minister may issue ordinances for restriction or prohibition of weighting of export silk fabrics and for indications by which the quality and kind of weighting are to be distinguished, or other matters. (3) No refining business of export silk fabrics is allowed to be carried on without obtaining the permission of the Minister in accordance with the provisions of Ordinances. (4) In order to maintain or raise the reputation of export silk fabrics, the Minister may issue necessary ordinances regarding factory arrangements for refining or dyeing of export silk fabrics, the mode of operation, the materials to be used or other matters, or may stop work altogether. (5) When a refiner of export silk fabrics has violated, in carrying out his work, the provisions of this law or ordinances issued in conformity with this law, or the measures taken in conformity with this law, or has acted against public interest the Minister may cancel the permission already given in accordance with Article 3. (6) Competent officials may, if necessary, visit factories, shops, warehouses, or other places, and inspect the goods, books, or other articles, under a certificate of authority. (7) Any stamp or mark impressed by the Imperial Japanese Government Silk Inspection Office on export silk fabrics shall not be defaced, removed or cancelled without a proper reason.

No export silk fabric, on which the stamp or mark is impressed in accordance with the provisions of the preceding paragraph, is allowed to be exported if the stamp or mark is defaced, removed or cancelled.

Strict measures are enjoined to be taken against violators of these provisions who may be fined up to one thousand yen.

According to regulations under the law for the control of manufactures for export (Department of Commerce and Industry Ordinance No. 12 of 26th December 1927) inspection is directed to test—(1) Quality, which includes (*a*) yarn and work on yarn,

(*b*) texture, (*c*) weaving, (*d*) washing, bleaching, refining and finishing; (2) Weight; (3) Length and width; (4) Defects, stains, cuts and breaks in warp and weft; (5) Other items indispensable in determining whether to be "passed" or "rejected".

Weight, length and width are determined by actual weighment and measurement in a properly dry condition. Inspectors are required according to regulations in force in Kanazawa prefecture to visit refineries in order to be able to judge that at least 17 per cent. of the original fabric is boiled off. In order to find out defects, stains, etc., the whole piece is required to be passed through "general inspection" stands (Figs. 54 and 55) and the speed with which the pieces unroll and pass down is regulated. For quality inspection a window with north light is used. Texture is determined by warp and weft threads under a textile examining glass in an area of ·6 inch square at different places in the fabric. For different grades of the various kinds of fabrics the number of warp and weft threads is specified in the regulations and similarly the thickness (*mome-zuke*) of various fabrics is also specified.

No use of magnesium chloride, tin salt, sugar or earth is allowed except in the case of crepe and dyed fabrics in which tin salt may be used; but complete records are required to be preserved for three years of the fabrics thus loaded, quantity of salt used, the name of refiner and purchaser and such fabrics are to bear a stamp indicating loading.

Refining and dyeing factories for export goods can be opened only with the Minister's permission which is given on scrutiny of detail as to methods, equipment and accommodation. The Minister is to be kept informed of erection of building and plant and commencement, stoppage, transfer and amalgamation of work for which permission is required. A complete record of fabrics dealt with is required to be kept.

Charges for inspection are fixed at two sen per piece.

There are various kinds of stamps specified by regulations and to be used with various kinds of ink to indicate the end of a piece, length, breadth and weight, thickness (*mome-zuke*), stains and defects, whether rejected or passed, guaranteed, descriptions such as *taffeta*, etc., and date and name of the finishing factory.

59. Protection to the weaving industry.

Import duties are levied at the rate of 25 per cent. on raw silk (except Chinese *tasar* which is required as raw material for *pongee*), 30 per cent. on thrown silk and silk yarns, 100 yen per 100 *Kin* (about 133 lbs.) on rayon, 50 to 180 yen per 100 *Kin* of wool and silk tissue and wool and cotton tissue and 50 to 520 yen per 100 *Kin* of silk tissue.

60. History of development in a few places.

A brief description of a few points of interest in the development of the weaving industry in a few places is added. The main weaving centres are the following

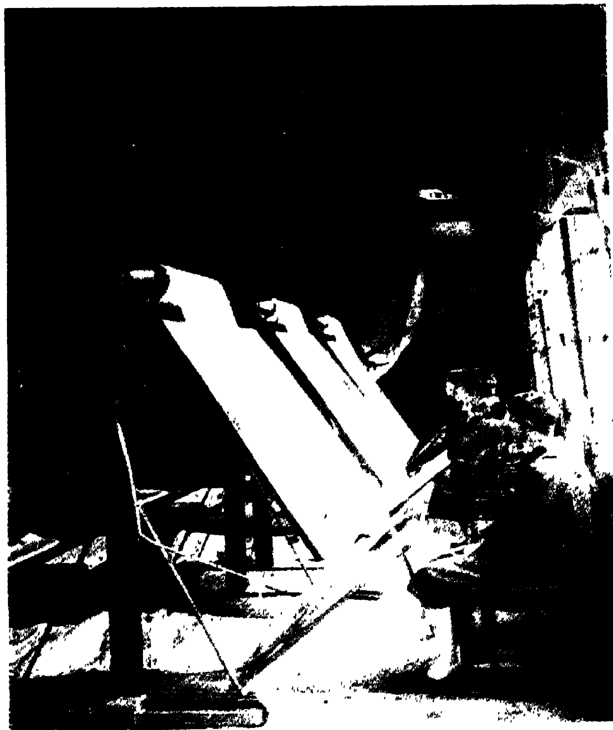


Fig. 54. General Inspection Stand (Fukui Inspection House).



Fig. 55. General Inspection Stand. This method is followed before washing. (Fukui.)

prefectures, practically in order of importance, *viz.*, Fukui, Ishikawa, Fukushima, Gumma, Kyoto, Gifu, Yamagata, Kobe, Kanagawa, Aichi, Toyama and Tochigi.

Fukui prefecture.

The principal silk goods produced here are *Habutae*, *Pongee*, *Fuji*, and *crepes*. About 1886 when Fukui goods began to be exported, the value of export goods was about Yen 60,000. But by 1919 it rose to Yen 170,000,000, an increase of 2,700 times. About 1929 the consumption of raw silk by Fukui weavers was about 10 per cent. of the world's consumption and the output of silk goods represented about 5 per cent. of the world's and 20 per cent. of Japan's production.

About 1887 hand looms only were in use. About 1921 out of about 34,000 machines in operation about 27,000 were power looms and by 1929 hand looms disappeared.

This success is due to the following—(1) Close co-operation of the Government with the manufacturers and help in the form of subsidies and banking facilities. (2) Introduction of power looms. (3) Research in an industrial experiment station specially started in throwing, dyeing, boiling-off, weaving processes, refining, finishing, embroidery, etc. This institute played a great part in the introduction of power looms. (4) Facilities of training in a Technical Institute especially started. The term is five years. The passed graduates mostly work in their own houses or in other's factories. Apprentices are trained in evening classes. (5) For uniformity of production co-operation and voluntary amalgamation of concerns in the same line of work, *viz.*, inspection of raw silk, throwing, dyeing, boiling-off and finishing. (6) Associations, guilds and societies. The principal one is the Fukui Textile Guild embracing the whole prefecture and formed according to the Law of Staple Products Guild in 1900. It includes all silk textile, export cotton textile and thrown silk manufacturers, silk merchants and refiners. The rules of this guild state (*a*) that members shall introduce themselves to one another and give information about necessary business matters, (*b*) that work-men and labourers will be controlled, (*c*) that thrift will be encouraged among works, (*d*) that foreign and domestic textile designs will be collected and displayed for the benefit of members, (*e*) that exhibitions will be held for improving quality, (*f*) that commercial and industrial representatives will be sent to all markets in the world and the results made known to members (A business representative and a textile expert are sent out every year to study markets as well as methods for improving technique. Such representatives of this guild have visited practically all the countries of the world), (*g*) that facilities will be afforded to members who wish to try new markets, (*h*) that arrangements will be made to display products in all markets of the world, (*i*) that communication will be established with cognate associations in other prefectures. This guild arranged for inspection or conditioning of all silk, rayon and cotton textiles. Sample books of textiles produced in the prefecture are prepared and supplied to all Japanese consuls in the world and to commercial travellers sent out by the Department of

Commerce and Industry. The expenses are met by certificate fees, manufacturing rate, commercial rate, cotton textiles inspection fees, quality stamp fees, workmen's certificate fees, license fees and others. The total outlay in 1921 was Yen 128,780.

Among other associations the following may be mentioned, *viz.*, industrial association for facility of monetary transaction among members and loans when necessary from Government, association for improvement of *habutae* manufacture and trade, that for improvement of *Pongee* manufacture and trade, that of brokers, that for equitable distribution of labour and that for introduction of power looms.

Gifu prefecture.

The principal production of this prefecture is *pongee* with *tasar* from China which really started about 1911 after the import duty on the raw material was removed.

In 1919 textile industrialists, brokers and refiners formed the Gifu *Pongee* Manufacturers Guild which also inspected the goods. Inspection was taken over by Government cloth Conditioning House started in 1920. As there was complaint about dis-uniformity of products all the refining factories in the prefecture were amalgamated into the Gifu Refining Company which carries on work at four centres. The guild was reorganised by elimination of those textile manufacturers not especially interested in *pongee* and transactions in the raw materials and finished products and packing of the export goods were improved.

Gumma prefecture.

Kiryu is the centre of weaving in this prefecture and has an old history of weaving. In 1919 the value of Kiryu's produce for home consumption amounted to about Yen 48,000,000 and that of export goods to about Yen 15,000,000. In 1878 a combination of 671 weavers in Kiryu City and 35 neighbouring villages resulted in Kiryu Company which was reorganised in 1892 and again in 1897 into a guild after the passing of the Law of Staple Products Guild and finally in 1905. The aim is to standardise product, prevent output of inferior goods, improve quality, extend market and safeguard the interests of members who operate about 16,000 looms and employ about 23,000 workers.

The Kiryu Technical Institute was started in 1915 and by 1929 turned out eleven batches of graduates. The course is for three years and in 1929 there were 300 students on the roll. It has four departments *viz.*: (1) Spinning and weaving, equipped with various types of spinning machines for both cotton and silk, throwing machines and looms. A stuff was being spun from rayon refuse and American cotton. (2) Dyeing, printing and finishing, equipped with indigenous as well as European appliances and machinery. (3) Applied chemistry. (4) Mechanical Engineering.

A weaving factory of an ex-student of this institute was visited. He was working about a dozen power looms and weaving *Chirimen* crêpe for home consumption.

He invested Yen 7,000, engages 16 hands, purchases dyed thread, gets his cloth washed and finished at the refining factory at 1·20 Yen per piece, pays 80 sen per piece for Guild charges and conditioning and turns out 4,000 pieces in a year of the average price of 21 Yen each.

Kiryu has the largest throwing mill in Japan, the Nippon Throwing Company, which works 43,000 spindles with electric power at the rate of about 5 H. P. for every 1,000 spindles. It purchases raw silk, throws it and sells largely to Kiryu weavers and to weavers in other places in Japan and also to weavers in Benares in India. It has a dyeing department and sells dyed thrown yarn also. Kiryu has a large factory for manufacturing throwing machinery.

Kiryu has three cloth Conditioning Houses. (1) One run by the weavers guild for cloth used in Japan. (2) One run by the Prefectural Government for cloth exported to Korea. (3) One run by the Imperial Government for cloth for export to foreign countries.

Kyoto Prefecture.

Nishijin weaving is a very ancient art. About 1869 eighteen Nishijin factories were organised into an association. In 1892 under orders of the prefectural Government Nishijin Weavers Association was reorganised. This association has established a museum, and experimental laboratory for dyeing and weaving.

Dyeing and printing. Kyoto is the centre of dyeing and printing. A large quarter of Kyoto town is occupied by dyers and printers. A canal runs through it and its water is always dyed with the washing of the dyeing and printing factories. These factories are small, engaging from about half a dozen to a dozen or two of hands, and the largest one engages less than 50 hands. As the workmen are fed and housed these factories are much like house-hold establishments. Boys are taken as apprentices and given food, clothing and living accommodation and a few yen as pocket money. They learn for about ten years and their monetary allowance is increased every year. On satisfactory work they are helped to set up independent business, the patronising factories standing surety for initial requirements. In piece and yarn dyeing establishments there are waterpipe and steampipe connections to the vats. Other appliances used are bamboo rods and wooden ladles. German dyes were being used and drying was being done in the shade in airy rooms upstairs. In the printing houses long wooden planks are in use for Kimono pieces which are narrow, usually about a foot wide and less than about 30 feet long. The patterns are cut in sheets of oiled paper. The piece to be printed is stretched on the plank and the pattern papers, each about two feet long, are pinned on the piece. The colouring matter is mixed with rice starch and salt and made into a soft paste which is taken with large spatulas and applied thinly over the pattern papers. When the papers are lifted, the paste sticks to the piece in patterns and when dry another

pattern may be added. In the end the piece may be dyed in order to give a colour to the ground work. Frequently old patterns are removed and new ones printed on old pieces which are said to be sent here for the purpose from all over Japan.

The Kyoto First Technical School has 700 boys on the roll. There are the following six departments and the course is for five years in each department :—

(1) Weaving, equipped with various types of looms (70 students).

(2) Dyeing and printing (150 students)—both according to Japanese and European methods for which European machinery is in use.

(3) Industrial chemistry.

(4) Mechanical engineering.

(5) Electrical engineering.*

(6) Architecture which includes carpentry, masonry and designs of buildings.

* In the electrical department students were preparing electrical irons, price Yen 1·90 each and electrical heaters price Yen 1·70 each. Cheap electrical power is probably the one main factor in Japan's industrial development. Even in subdivisional towns soldering of tin and boring of iron were observed to be carried out with electricity. Practically all cottage industries make use of electricity.

APPENDIX A.

WILD SILKS OF JAPAN.

1. Japanese Tasar—*Tensan*, *Yamamayu* or *Yamamai* (meaning hill silkworm)—*Antheraea yamamai*, Guér-Men.

Antheraea yamamai (locally called *Tensan*) is reared only in two places in Japan, *viz.*, Nagano and Ibaraki Prefectures, but mostly in Nagano.

The insect is reared on cultivated oak (*Quercus serrata*) locally called *Kunugi-nara*. The area in Minami Azumi county is 500 *cho* (about 1250 acres). The seedlings are raised in nurseries and planted about 6 feet apart in fairly well prepared land in spring and then allowed to grow without further attention. The plantation becomes ready for use about three years after planting. The plants are not allowed to grow tall but kept down to a height of five or six feet by pruning carried out in the cold weather from December to February or March. They become bushy.

The eggs are gummed on long strips of paper which are tied to branches before 10th of May. The worms on hatching crawl about and feed at will. The eggs hatch in about 10 to 12 days.

The larva feeds about 50 days. It takes 7 to 10 days to spin its cocoon and pupate and the moth emerges in about 7 days more. The worms are allowed to spin on the plants and the cocoons when formed are searched out and gathered. During rearing no especial watch is kept but in the mornings the owner just takes a round through the plantation.

In a *cho* (about 2½ acres) about 75,000 eggs are tied but the average harvest is about ten thousand cocoons and in especially favourable circumstances it may be up to about 15,000. Birds, ants and other natural enemies are responsible for the loss of so many worms. Pebrine occurs in the worms but is now controlled by examination of moths. Cocoons on harvest are separated into reeling and seed cocoons.

Preparation of seed.— The seed cocoons are arranged in trays 3′ × 2′ with their emerging ends turned upwards and the moths on emergence crawl on to the edge of the trays and hang until their wings harden. Then a female and one or two males are confined in an open meshed conical or rather bellshaped bamboo basket with the base open. The open base has a diameter of about 8 inches and the height of the basket from base to vertex is about the same, the meshes being about one inch wide. The open end is covered with a piece of paper well secured so as not to allow the moths to escape. Pairing takes place in the evening and lasts till the next evening when eggs are laid. These baskets are hung up in a high open shed, the one we saw having a tin roof. The female moth is taken out at leisure, numbered, packed and sent for microscopic examination in the local controlling station.

Each moth lays about 200 to 250 eggs, which are glued in batches to the framework of the basket. The eggs are allowed to remain in ordinary temperature till about next spring when they are scraped off, washed in water and subjected to a temperature of about 40°F, for twenty days and hatch in about 10 days after removal from the cold storage without any kind of incubation. The price of seed cocoons is 3 sen each.

The cocoons for reeling are dried in a rough sort of drying chamber with ordinary fire to about 40 per cent. of their green weight. The price of reeling cocoons is 1½ sen each. The yield of reeled silk is about 7 *momme* (about 406 grains) from 100 cocoons with varying quantities of waste. Reeling is done without any kind of previous cooking. The reeling basins are small ordinary enamelled cooking pans placed directly over ordinary charcoal fire. Only one thread

is reeled with filaments of 4 to 5 cocoons. The filament of a cocoon is about 500 meters and its denier about 5·5. The factory we saw had 24 basins of which 12 were working, the driving power being supplied from a water wheel. The raw silk was re-reeled into ordinary hanks. The croisure given was about 18 inches. The machinery was of ordinary type. The wages were paid by piece work at the rate of 40 sen per 15 *momme* of reeled thread. One reeler girl or woman produced 15 to 20 *momme* a day of about 11 hours with ordinary interval.

The present price of the silk is Yen 4,200 per 10 *kan* (84 lbs.) or about Yen 52 per pound. Honda recorded Yen 65 per *kan* in 1909.

The waste is spun into thread by hand.

2. Chinese Tasar—*Sakusan*, *Antheraea pernyi*, Guér-Men.

It is reared on the same food-plant and in the same manner as *Yamamai* but at present on a small scale. In China it is reared on a large scale and is the source of the cheap Shantung silk.

The insect hibernates in winter in the cocoon and every year seed cocoons are imported for rearing. Moths emerge about May and lay eggs which are scraped off from the baskets and put on plants after about 15 days. The worms feed for about 50 days and then spin cocoons. More than 100,000 eggs distributed in about 2½ acres of plantation yield about 20,000 to 25,000 cocoons. These spring cocoons reel well. After about 25 days of spinning moths emerge and lay eggs which hatch in about 10 days and the resultant larvae feed for about 40 days before spinning cocoons which hibernate. Commercial rearing is not carried out in autumn.

About 8 *momme* (about 464 grains) of silk is obtained from 100 cocoons. The length of the filament of a cocoon is about 650 meters and its denier about 4·8.

3. *Shosan* or *Shotyu*, *Caligula japonica*, Moore.

It is not reared but wild cocoons are collected. The worms feed on camphor, chestnut, walnut, etc. Eggs hatch about April-May and the worms, after feeding for about 50 to 60 days, come down to spin on shrubs and bushes. Moths appear in August-September and the eggs which are laid hibernate and hatch next year. The cocoons are open at one end like those of Assam Eri (*Attacus ricini*, Drury) and are made into floss-silk (*mawata*).

4. *Chosan*, *Attacus cynthia*, Drury.

The worms occur wild and feed on *Ailanthus* and their cocoons are not collected.

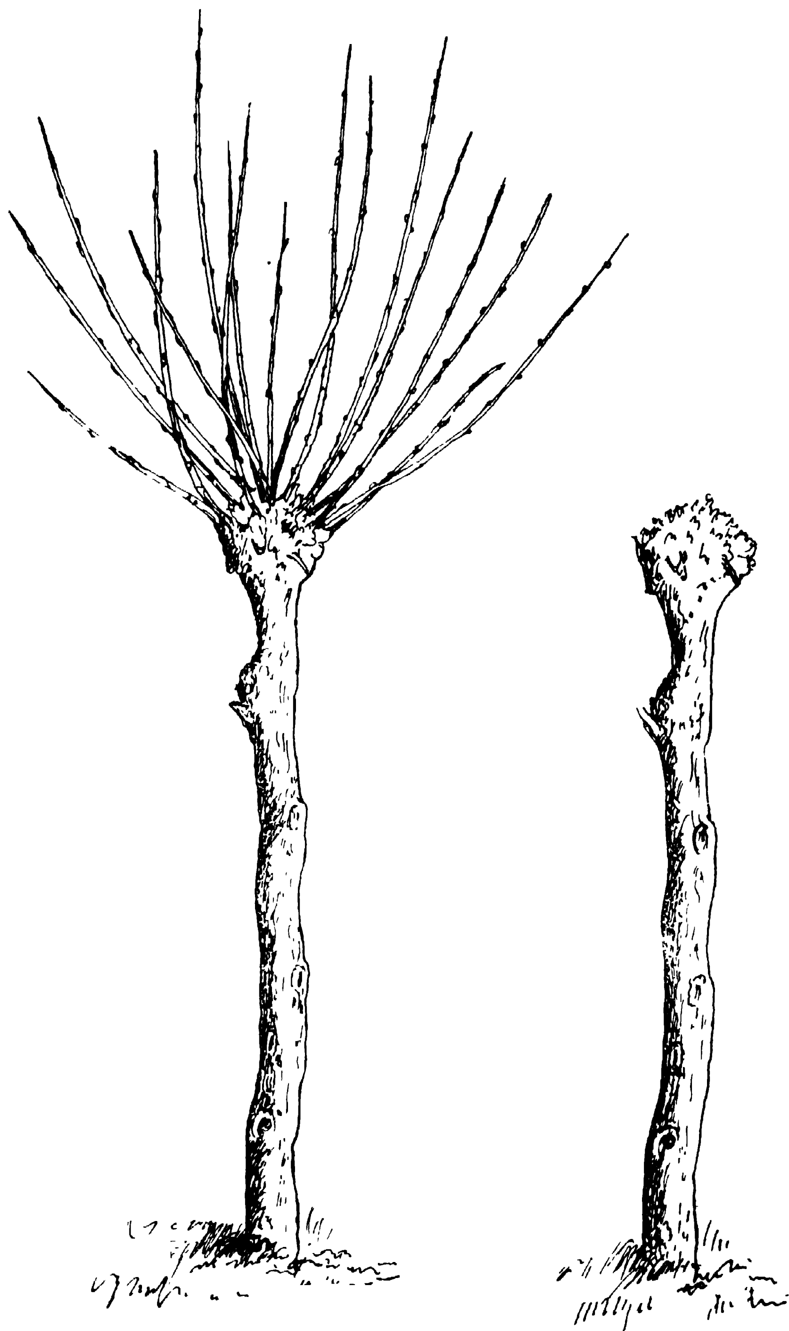


Fig. 56. Mulberry tree of France and Italy. The right hand figure shows how it is pruned and the left hand figure shows it in winter.

APPENDIX B.

A NOTE ON SERICULTURE IN FRANCE.

Mulberry.

Mulberry, varieties of *Morus alba*, is practically wholly of tree form (Fig. 56), the trees being grown on embankments or among fields. Attempts are being made to introduce a low bush form. Nursery men raise seedlings which after one year are sold (current price 25 centimes each in 1930) to grafters or cultivators who carry out grafting. Grafts are sold after about a year or a year and a half (current price Fcs. 2·50 to 3 each in 1930) and planted out, and plucking of leaves is not commenced before about ten years.

Egg production.

There are sixty-five egg-producing establishments, all on hillsides in the south of France, with their own experts and microscopists. For their control there is a Government department with one Director and 20 inspectors. The establishments have to send in reports of prospective rearing. The inspectors supervise rearing and note occurrence of diseases and also shape and silk content of cocoons. Cocoons which are passed can be used in the production of the industrial seed which is used by rearers. Egg production is not permitted unless done by one who possesses a certificate of training in the Sericultural School at Montpellier. The egg-producing operations are carried out in July and completed by about 15th August. The parent seed is produced by the cellular method. For industrial seed no definite percentage is fixed for examination, but the inspector takes any number according to his discretion and a trace of pebrine entails rejection of the lot. Filatures usually purchase eggs and give to the rearers and agree to purchase the resultant cocoons. This is said to stimulate rearing as it is found that otherwise many rearers would not do any rearing. Rearers can produce their own eggs, but in order to encourage use of examined eggs from egg-producing establishments, a bonus of 2·40 Francs is given by the Government on each kilogram of green cocoons produced. The rearers take their cocoons to the town hall where the Mayor pays this bonus on production of a certificate from the egg-producing establishment from which eggs had been purchased.

Rearing.

Rearing is done only of pure races, usually Ascoli A. S. L., Ascoli B. N., Bionne pure, Bionne striped, Bionne spherical and Gros Var. Hybrid races were tried and yielded more silk which, however, was considered irregular and the filatures preferred to stick to quality, and rearing of hybrid races was abandoned. Hibernation of eggs is commenced in cold store at 0·C to 1·C (32°F to 34°F) in October and lasts for about six months. Incubation of eggs commences about 20th April and rearing and harvesting of cocoons completed by about 15th June.

Disposal of cocoons.

The harvested cocoons are taken to the town hall and weighed. Filatures accept this weight. Cocoons are then transported to the purchasing filatures quickly by special arrangement with the railway. Stifling and drying are done by the filatures.

Price of cocoons.

When production used to be much larger than now there were cocoon markets which have almost disappeared and with their disappearance filature owners began to exploit the rearers. Therefore Government stepped in and set up a Committee. The rearers can sell cocoons in three ways. (1) In a market, where there is one, by haggling. (2) The Government Committee fixes a minimum price of cocoons calculated on the price of silk at Lyons in March, April and May and this price is published before rearing is undertaken. Rearers receive this minimum price on delivery of the cocoons. The Committee sits in November again and revises the price on the actual prices of silk prevalent from 15th May to 16th November. Within 20 days of this meeting the rearers receive the difference between the minimum price already paid and the revised price. (3) The rearers receive two-thirds of the minimum price fixed by the syndicate of filatures on delivery of cocoons and the balance within 20 days of the meeting of the Government Committee which revises the price at the end of November as above. The Committee adopts the following procedure in revising the price:—

(A) Take the average price of silk at Lyons from cocoons produced in Cevennes, from 15th May to 15th November.

(B) Subtract from (A) 9 per cent. for general expenses for sale at Lyons and Francs 50 for filature expenses.

(C) Divide the remainder of (B) by 11·5 which represents the average number of Kilos of cocoons to produce one Kilo of silk.

(D) Subtract from the result of (C) Fcs. 1·50 for cost of eggs, transport, stifling, etc., or Fc. 1 if the farmer has purchased the eggs himself. The figure thus obtained is the price of green cocoons per Kilo.

The farmers preferred the method (2).

In 1930 when the price of silk was going down it was settled before the rearing season that the above Committee would not function and the following three methods would be open—(1) sale in open market, (2) sale at price fixed according to the silk price in March, April and May with payment at delivery and (3) sale at price fixed according to silk price from March to October with payment of two-thirds of the price on delivery and of the balance in November.

Education and propaganda.

Sericultural education is provided for in the Sericultural School at Montpellier.

The National Office of Sericulture at Valence is not a Government department but all its expenses are met from funds provided by Government. It was originally started by the silk manufacturers of Lyons without any help from Government.

It still receives private subscriptions and donations. From every Fcs. 2·40 paid as bonus per kilo of green cocoons to rearers this organisation receives Fcs. 0·40 and similarly a share of the bonus paid for reeling.

The functions of this organisation are-(1) to develop mulberry and get nurseries established for the purpose, (2) to develop co-operative incubation chambers, cooperative rearing and cocoon drying chambers, (3) to spread knowledge of disinfection methods, (4) to develop cooperative organisations against risks of loss in rearing, (5) to arrange for experiment and investigation by grants, (6) to help propaganda by the publication of statistics.

It helps the farmers by buying up mulberry plants at wholesale rate and making them available at cost price and by giving grants amounting up to about half the cost when a new plantation is successfully started. It is trying to introduce bush and medium forms of mulberry.

APPENDIX C.

A NOTE ON SERICULTURE IN ITALY.

Mulberry.

Mulberry is mostly of tree form as in France, the trees being grown in the midst of cultivated fields. They are said to last 50 to 100 years. For economic reasons bush mulberry and medium tree forms as in Japan are being advocated. According to Prof. Pigorini medium trees last about 10 to 15 years and bush about 8 years. All are grown from grafts. Plucking of leaves is commenced from bush in the second year, from medium trees in the third year and from trees in the sixth year. Mulberry seedlings and grafts are raised by nursery-men and sold to the rearers. *Morus nigra* (grown in the south of Italy), *M. alba*, *M. alba* var. *cattaneo* and eight other varieties are said to be grown. In a very large nursery of Fratelli Sgaravatti Piante at Saonara near Padua, the stock used for grafts was *M. alba*.

Egg production.

There are 172 egg-producing establishments and their control is assigned to different Government Institutions. The producers are required to communicate within the month of April the places and other details of rearing.

Rearers are permitted to rear their own eggs if they like but cannot sell or give them to others.

The Law No. 1512, dated 28th June 1923 and Regulation under it No. 1204, dated 26th June 1924 for the control of production and sale of silk-worm eggs, provide that egg-production will be allowed to be carried out only according to the cellular method under permission granted by the Ministry of Agriculture on the satisfaction of a scrutiny regarding accommodation and appliances for the production of at least 500 ounces of pure seed or 1,500 ounces of hybrid seed and also regarding methods and competency of staff and on proof being provided that the applicant has joined or applied for joining the chamber of commerce and industry of the place as seed producer. The cellular method must also be followed by Italian firms carrying on work abroad. The staff is not considered competent unless possessing a certificate of training in one of the Royal Institutes of Agriculture at Milan, Perugia and Portici or the Sericultural Experiment Station of Padua and Ascoli-Piceno. The candidates for such training must be graduates of a second-grade middle school, Technical institute or middle Agricultural school or pass an entrance examination in physics, chemistry, zoology and botany of the same standard as in a second-grade middle school.

The rearing of the seed is supervised by Government inspectors who have free access to all rearing establishments and observe the condition of the parent worms. The actual examination of the moths is carried out by the producing establishments. For controlling and checking this examination a quantity of eggs amounting to 4 grams of each lot is taken, divided into two samples, sealed in presence of witnesses, and sent to two different Government institutions. If the report of the first institution, which is to be communicated before the end of February through a registered letter, be unfavourable and be appealed against within five days, the second institute carries out examination of the second sample and its report, which is to be communicated by registered letter within 15 days, is final. Presence of pebrine necessitates destruction of the whole lot within ten days of the report in the presence of the Inspector concerned. One ounce of pure seed is 30 grams and one ounce hybrid seed (indigenous yellow female crossed with Asiatic male) is 33 to 36 grams. The hybrid F_1 cross seed must be of pure races and be indicated by the races of both the male and female moths. The seed must be packed in a way so as not to be touched by hand.

Sale of eggs may be effected by the authorised producer direct or through representatives whose names should be communicated to the controlling institute before March, but not through itinerant hawkers. Eggs in possession of itinerant hawkers are summarily destroyed. Eggs produced for sale without authority are also destroyed and with the help of the police if necessary. A tax is levied by the Ministry of National Economy at the rate of ten cents on each ounce of seed sold, 10 cents on one ounce, 5 cents on ½ ounce, 2½ cents on ¼ ounce and 1¼ cents on ⅛ ounce in the form of tickets or stamps which are defaced by a seal of the year of sale.

When eggs are sold in separate cells 100 layings are taken to be equivalent to one ounce. The funds thus collected are kept separate and used for meeting expenses of supervision and examination.

Import of eggs for rearing is permitted only in separate cells accompanied with the moths which laid them except in the case of eggs which are received for study and experiment and are addressed to the three Agricultural Institutes and the two Experimental Stations. The responsibility about eventual pebrine infection in the case of foreign eggs lies on the firm selling them.

Violation of the law and regulation entails a fine of Lire 50 to 1000 which may be doubled on repetition of offence.

Rearing.

Pure races are reared except in the plains of Northern Italy where first generation hybrid races are reared. In the eastern parts the temperature in the rearing season is said to be between 30°C and 32°C (about 86°F and 90°F).

Eggs are at present hibernated in refrigerators at 2°C to 3°C (about 36°F to 38°F) from about the end of December to about the end of March. The rearing season in south Italy is 1st April to 1st May and in North Italy 1st May to 1st June. Incubation is either done in an incubation room before the seed goes into the hands of the rearers or the rearers themselves take the eggs and incubate them. Incubation is done by raising the temperature by about 3 or 4 degrees every day to about 70°F in the course of about 15 days.

Sale of cocoons.

There is no organisation for fixing the price of cocoons and it is a transaction between rearers and filature owners through simple haggling. Cocoons are purchased in the raw condition by filatures through their own agent and then dried with steam heat and stored in large gunny bags which are heaped in the store. The quotations in the newly established Silk Exchange have begun to regulate the price and that of cocoons passing through the Conditioning House is now fixed by a reeling test of 4 kilograms in an established filature for which a charge of Lire 40 is paid.

Reeling.

Reeling is done on to large hanks of which denier only is tested by taking 450 meters. The hanks are examined for dirt, etc., which are picked off and no re-reeling is done.

Waste.

Great care is taken in preparing the waste. The long waste is kept separate and all dirt is picked out from it. The unreelable portions of the cocoons are boiled with pupae, the pupae separated and the stuff is then ried and beaten with sticks in order to remove the dirt.

Dry pupae are sold for use as manure or expression of oil.

Experiment, teaching, training and propaganda.

The institutions connected with Sericultural education and training in Italy are three Higher Agricultural Institutes at Milan, Perugia and Portici, one Sericultural Experimental Station at Padua started in 1871 and one Experimental Station for mulberry culture and sericulture at Ascoli-Piceno started in 1920. There is one organisation for propaganda.

APPENDIX D.

SILK *VS.* RAYON (ARTIFICIAL SILK).

There is still some apprehension in many quarters about rayon ousting silk. This will never happen as rayon cannot be a substitute for silk. Mr. H. Tanaka of the Imperial Japanese Sericultural Experiment Station has compared the essential properties of silk and rayon and his graph is reproduced below. It is self explanatory.

Fig. 57

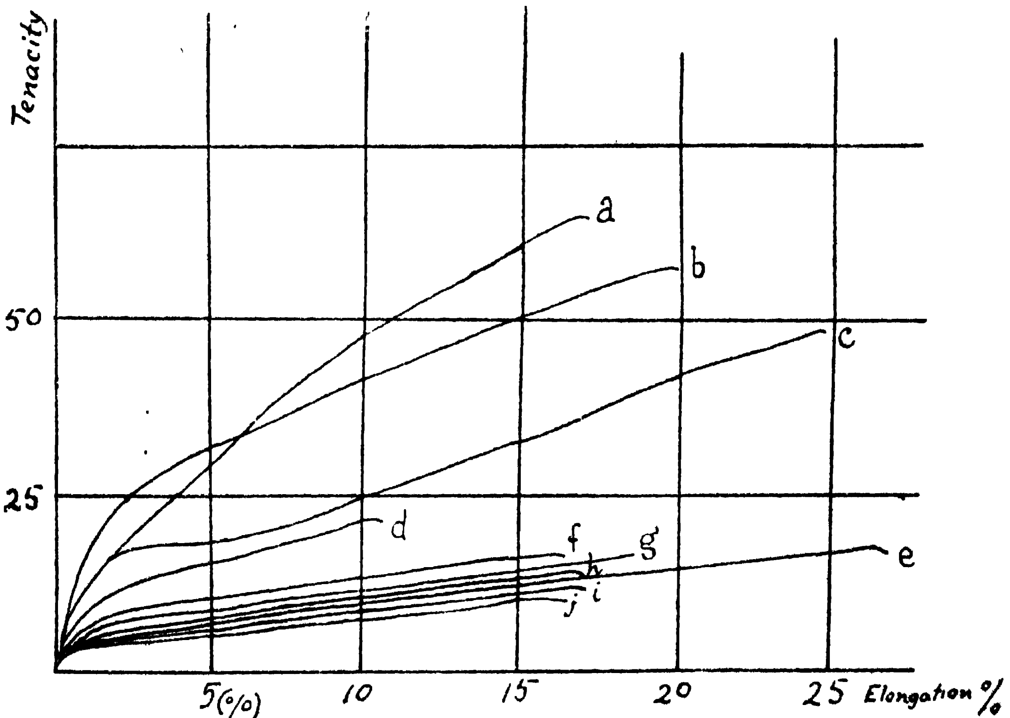


Fig. 57.—*a* Silk boiled off. *b* Raw silk. c Tasar (A. mylitta) raw. *d* Rayon—Fr. Cardonet. *e* Rayon—English viscose. *f* Rayon—Swiss viscose. *g* Rayon—Japanese viscose (Hiroshima Mill). *h* Rayon—Japanese viscose (Yonida Mil l). *i* Rayon—Belgian viscose. *j* Rayon—Japanese Cupramonium. (After H. Tanaka.)

Below is quoted part of a paper read by the writer on "Sericulture in India" before the British Indian Union, London, and published in the *Indian Textile Journal* for April 1930. It explains the position of rayon as a competitor of silk. Strange as it may seem, rayon is stimulating production of certain classes of silk. Both in England and France importers were anxious to have a white silk which could be worked with rayon without being required to be bleached.

" After having given an idea of the sericultural industry, it seems necessary to discuss whether there is scope for it, especially in view of the apprehended competition of rayon or what used to be called artificial silk. Fears about this competition based no doubt on uninformed data have been the cause of much mischief and loss to India in that they prevented schemes of sericultural development being adopted. On account of its similarity in appearance to silk and its former name, rayon caused not a little anxiety to producers of silk. It is a vegetable fibre and is made by dissolving wood, especially pine wood, with chemicals and then drawing out the liquified pulp into filaments. Its nature is now being understood. It has come to be considered as a fourth fibre for clothing material in addition to cotton, silk and wool and is settling down to its own uses. As a matter of fact, much of its competition with silk is due to its deceptive appearance and ignorance of the consumers, who confuse it with silk in all countries including India. But people are learning by experience. Last year's report of the Silk Association of America notes a distinct reversion to silk from rayon in hosiery in America. A similar case has come to the knowledge of the writer in a large weaving centre in Burma. America being the largest customer, taking more than 90 per cent. of her raw silk supplies from Japan, the Silk Association of America has proposed to Japan to help in propaganda to educate the public as to the nature of silk and rayon. On the other hand, rayon is helping silk to a very great extent in mixed goods.

If we look into the production of silk and rayon the figures go to prove that rayon is hardly affecting silk. The figures of production and export of the principal silk producing countries for two recent years are quoted from the statistics published by the Silk Association of America.

	1924-25. lbs.	1928-29. lbs.
Rayon—		
Production in the world	85,000,000	400,000,000 (50,000 lbs. in 1920.)
Raw silk—		
Production in the world (Export figures only of India and China included in this)	85,000,000	105,577,000
Production in Europe	25,066,000	28,376,000
" Levant	1,984,000	2,381,000
" Japan	62,642,700	87,501,800 (30,995,000 lbs. in 1915.)
Raw silk export from—		
Japan	49,281,000	724,866,000
Shanghai	10,506,000	14,018,000
Canton	6,550,000	5,919,000
India	200,000	231,000

N. B.—Excep that of Canton all the above silk is the product of one-brooded races of worms.

Production of rayon has gone on increasing by leaps and bounds. But experts are expecting a saturation point in the near future.

As regards silk, it has maintained its increase at about six per cent. per year. Some are of the opinion that the demand for it will actually increase at a greater rate. At present the United States of America is the largest silk consuming country. She imported about 73 per cent. of the world's production in 1928-29, and about 68 per cent. in 1924-25. During the same period Japan noted a very large demand from Canada. It is reasonable to expect that other countries which develop like Canada, will consume larger quantities of silk. It is this belief or rather certainty about increase in demand for silk which is leading various countries to make fresh efforts at increasing its production. In Japan, which is at present the largest silk producing and exporting country in the world, fresh areas are being placed under mulberry, and there has been a proposal to plant mulberry on both sides of railway lines. The Japanese Government is vigorously pushing on schemes of sericulture in Korea and Formosa. In China the Nationalist Government is trying to organize this industry on scientific lines and with this end in view has recently purchased the silk Conditioning House at Shanghai which was started and hitherto run by the Silk Association of America. The American silk manufacturers are contributing money to the foreign silk associations in China for development of sericulture in that country mainly as a protection against Japan's absolute monopoly. The largest reeling concern of Japan has recently secured lands in the Dutch East Indies with the intention of developing sericulture there. In Brazil efforts are being made to develop a sericultural industry, and Japanese settlers are being welcomed who are expected to help the scheme. One representative from Brazil was studying the industry in Japan in 1929. The Imperial Institute of England is trying to establish sericulture in Tanganayika and other places in Africa. These attempts on the part of those who are in a position to judge the trend of the industry should allay all fears about the future of silk. As a further evidence of the importance of silk it may be stated that in addition to the hitherto only one raw silk exchange at Yokohama three new raw silk exchanges have come into existence recently. One was opened at Kobe in 1923. A second one was formed at New York in 1929, and a third one in Italy in January 1930."

The correspondent of the *Rangoon Gazette*, 11th June 1930, wrote from London in May 1930 that the manufacturers of silk, badly hit by rayon about eight or nine years ago, were having record sales during the last two years owing to the public's discovery that rayon cannot equal high-grade silks. The same correspondent gave the information that one of the most important silk manufacturing companies in Lyons was engaged in negotiations for buying a large rayon factory in England and fitting it up with French machinery for producing high grade silk brocades.

Japan within the last few years has made a phenomenal development in export rayon goods and she finds that this does not interfere with her export silk goods. Some entertain fears about rayon goods competing with cotton goods.

Since writing the above further development has taken place. Russia has adopted measures to develop sericulture as a part of the Five Year Programme of industrial development and has engaged Japanese experts for the purpose. The cocoons produced have found their way to Italy to be reeled. In order to develop a reeling industry the Soviet Government has decided to erect a silk filature of Japanese type in the central part of Russia. Machinery has been ordered from Japan and two Japanese experts will work here as engineers and instructors for about three years. Russian raw silk has already appeared in the American market.

A silk-Research Laboratory and Technical School has been established in south-western Germany for breeding superior stock of worms, distributing eggs and improving mulberry.

In China more sericultural stations have been established, there being now nine such stations in Kiangsu and Chekiang. Arrangements have been made for the Central Bank of China to

advance 3,000,000 dollars at 4 per cent. interest to the Silk Industry Bank which in turn will make advances to producers to improve and modernise every aspect of the industry. Since April 1930 compulsory conditioning of export raw silk has been enforced.

In Canton the industry has received large monetary help amounting to about G$ 200,000 from America and in 1923 the Provincial Government made an annual grant of about G$ 70,000 for the improvement of the industry to the Lingnan University, formerly known as Canton Christian College. In 1930 Government created the Kwantung Raw Silk Testing Bureau as a part of the Department of Reconstruction. Conditioning of all export silk has been enforced and facilities created for export of raw silk with certificates of tests regarding quality. The School of Silk Industry of the Lingnan University and the Kwantung Provincial Bureau of Sericulture are co-operating with the Testing Bureau in improving the industry in all its branches and Government is taking steps to establish the industry in a more suitable area in north Kwantung by free grants of land.

Attempts are being made to develop sericulture in Iraq and Mexico.

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